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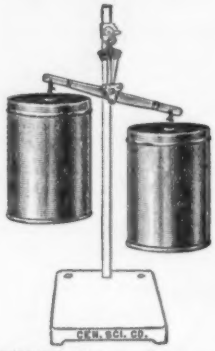

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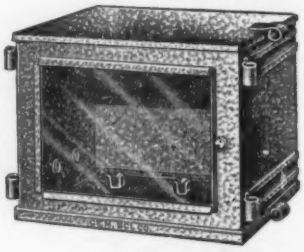

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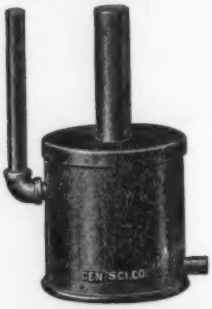

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Science Education

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ORGANIZATION OF SECONDARY-SCHOOL CHEMISTRY ACCORDING TO UTILITARIAN PRINCIPLES*

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In the following proposals for a reorganization of secondary school chemistry, the term "utilitarian principles" is used broadly to indicate that educational training should supply information which will function as largely as possible in the lives of individuals regardless of their occupation or status in life.

Now chemical information may function in many ways, such as giving pleasures of recognition and interpretation, reading and conversation, domestic activities, use in various occupations and professions, and health. The investigation[1] upon which the proposed organization is based attempted to secure a general analysis of all the utilitarian forms of chemical information by asking individuals of varying occupation, sex, and habitat, to apply two tests of relative utility. Peters has suggested four such tests:[2] frequency of occurrence, many-sidedness, cruciality, and personal appeal. Due to their similarity, it was thought that estimates of "frequency of occurrence" would give sufficient evidence concerning "many sidedness," and while the agreement between "cruciality" and "personal appeal" is not so apparent, subsequent developments justified the reliance of the study upon estimates of "pleasure or satisfaction" as indicative of these two tests.

Whatever may be said against the use of questionnaires, the fact remains that certain types of information can be had only by asking for direct testimony from the individuals concerned. Such was the demand of this problem. To this end a

* Paper given before a joint meeting of the National Association for Research in Science Teaching and the American Educational Research Association, Atlantic City, February 26, 1935.

[1] Wray, Robert P. *The Relative Importance of Items of Chemical Information for General Education.* Penn State Studies in Education, No. 6. State College, Pa.: School of Education, Penna. State College, 1932. Reprinted from the *Journal of Experimental Education,* Vol. I, No. 4, June, 1933.

[2] Peters, C. C. *Foundations of Educational Sociology.* New York: The Macmillan Company, 1932. pp. 60–65.

list of 1550 items of chemical information, including the illustrative ones in the following section of the first questionnaire, was taken from four chemistry texts commonly used in secondary schools: Bradbury, *A First Book in Chemistry;* Brownlee and Others, *Elementary Principles of Chemistry;* Fletcher, Smith, and Harrow, *Beginning Chemistry;* and McPherson, Henderson, and Fowler, *Chemistry for* Today.

The selection of the subject matter to be evaluated was done by going through the texts, one at a time, and writing down the items of information in as simple and concise a form as possible. The subjective element involved in the selection of the items forbids any positive claim for the inclusion of all possible information. However, the total list of 1550 items precludes any great omission of subject matter.

It would have been possible to add to the list a large number of items dealing with specific atomic and molecular weights, valences, equations, and problems. On the first two questionnaires used in the study some of the most common of the items of information pertinent to the above topics were included. Because there was a distinct tendency for these items to receive a low rating, it seemed appropriate to omit comparable statements that are even less familiar. For instance, it must be expected that statements of specific atomic weights of elements which are less known than those of oxygen and hydrogen will tend to receive correspondingly lower ratings. Again, if equations and problems as a class are rated low in usefulness, the less familiar examples will in all probability receive ratings lower than the mean of the class. This cannot be taken to imply that such topics of information need not be taught, but that their usefulness is low and that some other justification must be offered for their inclusion in the course. Chemistry teach-

QUESTIONNAIRE NUMBER ONE (SECTION)

Name..... Occupation.....
Address..... Number of Years Chemistry was Studied Beyond High School.....

Following are a number of items, statements, principles, etc., which are found in a general chemistry course. You will readily recognize that these items do not all have the same value or "utility" to you. It is to ascertain this value so that we may know which items are most important and hence should be stressed more in the teaching of chemistry that this study is being made.

Will you kindly check the following items in two respects: first as to Frequency of Occurrence (that is, the relative number of times each item occurs to you in your life activities); and second, as to Pleasure (that is, the degree of satisfaction or pleasure that it gives you to understand the item when you meet it in your experience).

Check each item in the column which most nearly represents its relative frequency and pleasure to you. If there are some items which you never learned, do not attempt to check them. *First, go through all the items and check them for frequency. Then, go through the list a second time and check the items for pleasure.*

1. Oxygen is the most abundant element in the earth's crust.
2. Oxygen was first obtained by Priestley in 1774.
3. Oxygen was first obtained by heating a red powder—mercuric oxide.
4. Oxygen is usually prepared in the laboratory by heating potassium chlorate.
5. The speeding up of some chemical reactions is aided by catalytic agents.

Frequency					*Pleasure*				
Never	*Occasionally*	*Moderate*	*Often*	*Very Often*	*None*	*Very Little*	*Moderate*	*Considerable*	*Great*

ers will readily recognize the necessity for including some of this information as a basis for understanding certain chemical phenomena.

The various types of chemical information were distributed among fifteen similar questionnaires and no attempt was made at classification of the items until the "index values" had been derived. The directions for checking the statements of information appeared at the top of the first page of each questionnaire (see specimen section shown above). The respondents were asked to indicate the relative frequency of use of each of the items by checking in the appropriate one of the columns entitled, "never," "occasionally," "moderate," "often," "very often." The amounts of the accompanying pleasure or satisfaction were indicated by checking corresponding columns under "Pleasure."

The questionnaires were distributed to individuals in the following occupational groups who had studied a minimum of one year of high school chemistry: teachers, engineers, students, laborers, housekeepers, medical men, secretaries, business men, pharmacists, and nurses.

The papers belonging to each group were tabulated by halves for the sake of getting reliability coefficients, and then the two halves combined to give a total for the group. An "index value," indicative of the relative utility of an item of information, was computed by multiplying its median frequency value by its median pleasure value. In computing these median values, the upper limits of each of the five cells were arbitrarily given values of 1, 2, 3, 4, and 5, respectively.

Since the procedure used in this study makes use of the "method of estimates," it is fitting that evidence be introduced to show the reliability of this technique. For a long time it was held rather in disfavor and considered too subjective for obtaining reliable and consistent results. As a matter of fact, a number of experiments offer considerable evidence as to the feasibility of the use of this technique, not only in asking people for estimates as to the value of items of information in their lives, but in estimating the values of activities in the teaching profession,[3] rating scenes from motion pictures according to a scale of values,[4] evaluating the elements of cultural education,[5] making judgments upon the elements contributing to success in the Christian ministry,[6] estimating the interest value of subject matter in general psychology,[7] and in judging heights, weights, achievement and intelligence of children.[8]

The ability to make definite responses in regard to the frequency with which items of chemical information have been used, and the pleasure or satisfaction attending this use, is evidenced in this study by the high correlation between results obtained from two submissions of the same questionnaire to the same group. In the first case a list of sixty items was checked according to the general directions by a group of 22 graduate students in education. Two weeks later, without any previous warning, they were asked to check the items again according to the original directions. The Pearson coefficient of correlation (product-moment method) between the values obtained for

[3] Charters, W. W., and Waples, Douglas. *The Commonwealth Teacher-Training Study.* Chicago, Illinois: The University of Chicago Press, 1929. pp. 28–29.

[4] Peters, C. C. *The Relation of Motion Pictures to Standards of Morality.* New York: The Macmillan Company, 1933.

[5] Campbell, D. W. *A Technique for Evaluating the Elements of Cultural Education.* Unpublished Master's Thesis, Pennsylvania State College, State College, Pa.

[6] Moxcey, Mary E. *Some Qualities Associated With Success in the Christian Ministry.* Teachers College Contributions to Education, No. 122. New York: Bureau of Publications, Teachers College, Columbia University, 1922. p. 10.

[7] Lick, A. S. *The Measurement of the Interest Value of Representative Items Taught in Elementary Psychology.* Unpublished Master's Thesis, Penn State College, 1932.

[8] Swab, James C. *The Reliability and Validity of Pupil Estimates as a Measuring Tool.* Unpublished Master's Thesis, Pennsylvania State College, 1932.

the items on the two occasions was, $r = .98 \pm .008$. At another time, using 75 other items, a group of 38 seniors at the Pennsylvania State College checked the questionnaire. After a period of four weeks the group responded again to the same list of items. The correlation between the results obtained from the two submissions of the same questionnaire to this group was, $r = .96 \pm .008$. These two computations indicate a high degree of consistency for the responses.

Another type of reliability is involved in the question of the reliability of the "index values." How large a group is necessary in order that the responses by one half of them agree very closely with those by the other half? That is, do the relative values assigned to the items by the groups of respondents actually represent the values which would be assigned by the entire membership of the group? Suffice it to say here that, using the results obtained from the total number of respondents to each questionnaire, the average reliability of the "index values," as shown by the coefficients of correlation between chance halves of the groups with the fifteen questionnaires used in the study, was .933 with a range from .910 to .956. The total number of respondents to each of these questionnaires ranged from 84 to 176.

Following this summary description of the nature and reliability of the technique, it is now possible to investigate the significance of the "index values" which purport to indicate the relative utility of each of the items of information.

It is of interest to know what relationship exists between the evaluations given to the items by the various occupational groups. It was found that the average of the "index values" assigned to a certain list of items by one group of respondents differed from the index average assigned by other groups, but at the same time the relative order of preference for the items tended to be the same. Such agreement in the relative arrangement of the items is shown by the degree of correlation between the "index values" assigned by the total individuals in one group with those assigned by the total respondents in any other group. The results obtained with the fifteen questionnaires are shown most concisely by the average inter-group coefficients of correlation which range from .64 to .95 with an average of .84. The uniformly high positive correlations give evidence of a consistent relative utility for all groups regardless of occupational status. As a result of this observation, considerable reliance was placed upon the responses of widely scattered groups of high-school seniors who had studied chemistry in their junior year.

A further analysis of the significance of the "index values" asks what evidence can be introduced in favor of their validity. Obviously, a type of validity is offered by the extent to which critics will agree that the educational philosophy upon which the study rests is sound, and that the technique is in keeping with its basic tenets. Fortunately, certain comparisons of this study with the results of several other investigations offer concise evidence to indicate that the "index values" actually measure the usefulness of the items. These former studies employed various techniques to secure evaluations on the usual chemistry topics. In order to effect a comparison, "indexes of usefulness" were obtained from the results of the present study by computing the mean of the "index values" of all of the items of information concerned with whatever topics were held in common.

If it be granted that teachers are more conscious of the usefulness of chemical information to their pupils than are textbook writers, and that high-school teachers are more influenced by this utilitarian demand than are college teachers, the validity of the "index values" as measures of usefulness is strengthened by comparisons with the re-

sults of two studies by Nathanson[9] and by Bond.[10] The "indexes of usefulness" correlate .328 and .137 with teacher consensus and textbook consensus, respectively, on the importance of certain commercial processes. In other words, the results indicate that when teachers estimate the importance of commercial processes their ratings agree more closely with the "indexes of usefulness" than does textbook emphasis. In the other comparison alluded to, high-school and college teachers of chemistry assigned a rank order of importance to certain science topics. The correlation obtained by using the "indexes of usefulness" with the rank by high-school teachers is slightly higher ($r = .143$) than the correlation secured when the evaluations by the college teachers were employed ($r = .039$). No great difference between these correlations could be expected as the ranks assigned by the two groups agree very closely ($r = .917$).

The most outstanding evidence in favor of the validity of this study comes from a comparison with one phase of an investigation by Stemple[11] in which he displayed his results to show the apportionment of the activities of pupils, fathers, and mothers to various topic divisions of the science of chemistry. The coefficient of correlation, $r = .77$, between Stemple's values and the "indexes of usefulness" of this study is indicative of considerable agreement between these two measures of functional values of chemical information.

A further analysis of Stemple's results indicates that the various divisions of chemical information have about the same relative importance to individuals regardless of the type of community. The amount of this agreement in the activities of people residing in agricultural, mining, railroad, and oil and gas communities is shown by coefficients of correlation ranging from .97 to .99. A similar agreement was found between the science activities of pupils and their parents. These results are especially interesting in view of their support of a previously mentioned observation that chemical information has a consistent relative utility for all groups of individuals regardless of occupational status.

One more type of comparison deserves attention. In order to determine the relationship between the usefulness of an item of information and the extent to which it has been learned, difficulty values were secured for a number of chemistry questions in the College Achievement Test, Part I, and for almost all of the questions in the Columbia Research Bureau Chemistry Test, Forms A and B. Coefficients of correlation were then computed between these difficulty values and the median index values representing the usefulness of corresponding items of information from the present study. In each case there was a distinct negative correlation between the difficulty of an item and its usefulness, the four computed coefficients of correlation being, $-.48$, $-.50$, $-.45$, and $-.44$.

In the foregoing discussion of the nature, reliability, and validity of the technique used to secure responses from individuals indicative of the utilitarian values of chemical information, frequent reference has been made to the median index values which were computed for each of the 1550 items of chemical information. The results of the investigation indicate that these "index values" are distinctive measures of the relative utility of each of the items. Since these values are the ultimate accomplishment of the study, it is unfortunate that they and the items to which they belong compose such a bulk as to preclude their display here. An illustrative list of the evaluated items which deal with sulphur

[9] Nathanson, J. N. "Commercial Processes in High School Chemistry." *School Science and Mathematics* 26: 628–633; June, 1926.

[10] Bond, P. H. "Report of the Committee on the Relationship Between High School and College Chemistry." *Journal of Chemical Education*, April, 1925. pp. 269–275.

[11] Stemple, F. W. *Science Needs of Pupils in Small High Schools Based on an Activity Analysis.* Unpublished Doctor's Dissertation, Cornell University, 1929.

and its compounds is given at the close of this article. In the original selection of the statements from textbooks, difficulties were sometimes encountered in attempting to make brief statements that are true. The principle followed in these situations was to formulate the information into statements that would have general acceptance in elementary chemistry.

The basis of classification used to display the complete list of statements is the Periodic classification of the elements according to their atomic numbers—a basis of classification that has general acceptance in all realms of chemistry. In order to care for certain items that do not relate specifically to any element, an added category was provided and called "General Facts, Laws, Principles, Etc." So that each item might occur but once in the total classification, the attempt was made to place each one under the heading of the element with which it is usually associated. Starting with Group Zero and numbering serially to the last element in the General Group, the items were arranged within each group and family in accordance with their "index values." Percentile points were determined in order to provide a convenient means for showing the relative rank of the items within the total distribution.

Now that the basic information in the usual elementary chemistry course has been evaluated according to certain "utilitarian principles," what can be done to organize it for instructional purposes?

As this discussion proceeds it will be apparent that the proposed organization holds no brief for or against any particular technique of teaching, does not quarrel with proposed sets of units which emphasize the relation of chemistry to man, and challenges none of the much discussed objectives. This does not mean that these issues are no longer controversial, but rather that their consideration is apart from the immediate theme. The proposals will appear to some as radical, to others as a mere step in the right direction, and to many, it is hoped, as a practical and efficient means of providing for a school of any size a functional chemistry curriculum which will contribute to general education as well as technical preparation.

Before continuing, it must be agreed that the personnel of the usual chemistry class is such that not all of the available information can be mastered by every student. This implies, then, that either deliberately or otherwise, there will be a differentiation of the assignments to meet the various levels of ability. Quantitative differences are comparatively easy to make, but the accompanying qualitative distinctions have been confusing to both student and teacher. The real value of the investigation which has just been discussed lies in the valid provision offered by the evaluated items of information as a basis for qualitative distinctions. In other words, the information which ranks highest should be taught to all, and the less utilitarian information made the basis of the supplementary assignments. There is no apparent reason why this cannot be done by a skillful teacher even with the traditional daily textbook assignment, but the work will be expedited if a topic or unit assignment, adapted to about three levels of ability, is prepared beforehand.

The percentile points, which indicate the relative rank of the evaluated items of information, will serve as a convenient guide in the selection of the information for each assignment level. For example, the items which rank above the thirtieth, tenth, and zero percentiles respectively might constitute a convenient three level assignment. Some workers may prefer to ignore the least utilitarian information and, by way of illustration, set the designated limits at the fortieth, twentieth, and tenth percentiles. It is not necessary to think of these various percentiles as clear cut points of demarcation between assignment levels. Chemistry teachers will readily recognize the necessity for including certain information which ranks low in usefulness, such as specific

valences and atomic weights, as a basis for explaining certain chemical phenomena.

In support of the foregoing contention for a basic minimum assignment which will be within the grasp of most students, it will be recalled that the previously discussed investigation gave evidence of a consistent relative utility for all individuals regardless of occupational status. It was noted, also, that there was a tendency for the less utilitarian information to be the more difficult. The inclusion of this subject matter in the supplementary assignments provides for its mastery by the most capable students who, to a large extent, will be the ones to have a need for it in the further study of science. In other words, it is possible to provide for the many pupils in typical chemistry classes a functional curriculum such as only large schools sometimes offer in the form of a distinctly functional course.

Since there is not available a topic or unit scheme of subject matter classification that meets with general approval, it will be necessary that, for instructional purposes, a reclassification be made in accord with the plan of organization preferred by each curriculum worker, but characterized by both qualitative and quantitative differentiation of the subject matter within each unit. At the expense of several hours' labor, the original list of statements may be re-classified according to almost any unit or subject topics that may be preferred. The worker may exercise his preference frequently in regard to the placement of certain information that could be affiliated with any one of a number of topics. This is especially apparent when working with the carbon compounds or some of the more recent and less conventional functional units. Likewise, many statements of general facts, principles and laws may be associated with one or several of the units within the total scheme. Little difficulty will be experienced by those who prefer to group together the items concerned with such familiar elements as iron, oxygen, or sulphur.

Regardless of the scheme of classification employed, several uses suggest themselves. In addition to providing in a general way the objectives and key statements which may be turned into problems to serve as the basis for qualitatively and quantitatively differentiated assignments, the evaluated items offer a means for validating tests according to utilitarian principles, and they provide a plan for selecting the most information for such subjects as general science and so-called functional or practical chemistry courses.

In order to illustrate a type of classification just discussed and presented as a basis for several possible uses, the chemical information concerned with an ordinary chemistry topic, such as sulphur and its compounds, is given to show: (1) the nature of the items which were evaluated according to certain utilitarian principles; (2) the range and size of the median index values indicative of the relative utility of the items; (3) certain percentile points which indicate the relative rank of the items; (4) a basis for qualitatively and quantitatively differentiated assignments; and (5) the serial numbers of the statements in the original classification of the 1550 items of chemical information.

Serial Numbers	*Median Index Values*	*Percentile Points*	*Items*
			Sulphur and Its Compounds
1016	10.65		When sulphuric acid is placed on the skin it burns, due to the fact that it adsorbs moisture from the skin.
1017	10.46		Sulphur is used in making matches.
1021	8.90		The presence of hydrogen sulphide in the air causes silverware to tarnish.
		90th. 8.42	

1024	8.32	The peculiar odor of rotten eggs it that of hydrogen sulphide which has formed in the decaying process.
1030	7.10	When sulphuric acid is added to water heat is evolved.
	80th. 6.60	
1034	6.09	Sulphur dioxide is used in bleaching and disinfecting.
1036	5.80	Sulphur is used as a constituent of sprays for trees.
	70th. 5.50	
1040	5.38	Hydrogen sulphide arises from decaying food.
1042	4.78	The colors of many paints are caused by using metallic sulphides.
1045	4.58	Some substances, like sulphur, burn in oxygen with dazzling brilliancy.
1046	4.58	Sulphur is moderately active and joins with many metals.
	60th. 4.52	
1047	4.48	Zinc and dilute sulphuric acid react together to liberate hydrogen.
1048	4.39	Sulphur is found in nature in both the free and combined states.
1049	4.33	Sulphur is used in vulcanizing rubber.
	50th. 3.91	
1052	3.65	"Sulphur water" is due to dissolved hydrogen sulphide.
1054	3.40	Hot concentrated sulphuric acid acts as an oxidizing agent.
1057	3.27	Oil of Vitriol is the commercial name of sulphuric acid.
	40th. 3.26	
1058	3.18	Sulphur is extracted from beneath beds of quicksand by forcing hot water and air down through pipes to melt the sulphur and bring it to the surface.
1059	3.18	Sulphuric acid is used in the preparation of others acids.
1060	3.00	$S + O_2 = SO_2$.
1062	2.89	The pickling of metals so that paint will adhere to them may be done with sulphuric acid
1063	2.83	Carbon disulphide is highly inflammable and is used as a solvent for gums and waxes.
1064	2.78	Sulphur and highly heated carbon unite to form carbon disulphide.
1065	2.74	Sulphur dioxide may be both an oxidizing and reducing agent.
1066	2.73	The commercial forms of sulphur are roll sulphur and flowers of sulphur.
1067	2.67	Hydrogen sulphide reacts with some metals to form sulphides.
	30th. 2.66	
1069	2.30	Hydrogen sulphide acts as a strong reducing agent.
1070	2.19	Sulphuric acid has a high specific gravity.
	20th. 2.09	
1073	2.04	Sulphuric acid is prepared by the contact and chamber processes.
1076	1.92	$FeS + 2HCl = FeCl_2 + H_2S$.
1077	1.84	Hydrogen sulphide in water is a weak acid.

1078	1.78		The allotropic forms of sulphur are monoclinic, rhombic, and amorphous.
		10th. 1.52	
1079	1.43		Sulphur is extracted in Louisiana by the Frasch method.
1080	1.29		Rhombic sulphur is the most stable form, and at ordinary temperatures monoclinic and amorphous sulphur change to the rhombic form.
1545	1.21		$H_2SO_4 + 2\,KOH = 2\,H_2O + K_2SO_4$.
1081	1.18		The acid anhydride of sulphurous acid is sulphur dioxide.
1083	1.13		$H_2SO_4 + SO_3 = H_2SO_4 \cdot SO_3$.
1084	1.05		The test for the sulphate ion is the insolubility of barium sulphate.
1085	0.96		Sulphur dioxide is formed by a reaction between sodium sulphide and dilute sulphuric acid.
1088	0.46		An acid of sulphur is persulphuric acid, $H_2S_2O_8$.

MAJOR AIMS IN SCIENCE TEACHING

W. C. CROXTON

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Education, along with other agencies and institutions, is emerging from an era charged with too much smug complacency and too limited vision. Among educators, there is a growing consciousness that it is possible for schools to make a greater contribution to living. This awareness of inadequacy is the fertile soil in which educational planning is taking root. The first step is clarification of the goals toward which our efforts are to be directed.

Our problem in science teaching is clear. We must determine what we are trying to accomplish, instead of attempting to find possible uses for the traditional body of subject matter which we are teaching. We shall then be ready to plan suitable experiences to accomplish our purposes. It is pertinent to note here that most of the experimental studies of the relative merits of different methods of teaching science have not taken into account any comprehensive set of goals. There is need of further consideration and clarification of our aims. While the following aims are interrelated, it seems advisable to keep each objective before us that we may plan definite measures to achieve it. The order is not intended to suggest relative importance.

1. *To open new avenues of interest and satisfaction.* There are two reasons for opening new avenues of interest. New interests not only lead to educating interactions, but they provide ways of self-entertainment and satisfaction. Instead of cutting the pupil off from opportunities to find such interests, the school ought to be the agency which opens the gateways to new engrossing fields of activity. Recent changes have intensified this need.

Science offers a wonderful opportunity for developing rich and varied interests. To engage pupils absorbingly in growing plants, rearing insects, observing birds, revelling in photography, and in the joys of a home laboratory is to open to them avenues of interest and satisfaction which may lead farther into the realm of self-realization than the teacher can vision. There is not space here to list all of the avenues of interest and satisfaction which can be opened through science work. Each teacher should decide which avenues she will attempt to open through her science class, and should tread these avenues with the pupils until they become leisure-time interests.

2. *To lead to broader concepts and wider*

outlooks. Much of man's existence has been guided by superstition. A great deal of the primitive persists in our philosophy of life. More rational concepts based on the findings of science are very slowly permeating our thought. The slowness of their spread does not seem at all strange when we consider how little opportunity most individuals have had of a nature to lead to their comprehension. Yet no other knowledge has greater possibilities for human guidance than the broad generalizations and outlooks growing out of scientific principles. These concepts grow slowly out of a wealth of well-planned contributing experiences. They can not be taught as so many lessons, or preached to the pupils as abstract statements. It is important for the teacher to understand these concepts, together with their potentialities for guidance, that he may plan suitable experiences leading to their utilmate comprehension. The following list represents an attempted revision of the "Principles and Generalizations Suggested by the Committee as Valuable for Guidance in the Selection of Specific Objectives of Science Teaching" which appeared in Part I of the *Thirty-first Yearbook of the National Society for the Study of Education.* Exact quotations from the Yearbook are so indicated in the following list. Credit is due the authors of the Yearbook, and especially Craig, for some of the essential ideas involved in a number of the other generalizations, but the writer assumes responsibility for errors in the revised list. Any list is only tentative, and is certain to undergo further revision. It is hoped that the following list represents a contribution toward a more comprehensive analysis of this important goal.

Man's outlook, always limited by incomplete knowledge, is widened by each discovery.

Hypotheses and theories serve to stimulate and direct the search for truth.

The scientific method is simply a careful, orderly method of searching for truth.

Man's conception of truth changes.

Phenomena which appear miraculous and give rise to superstitions are explainable on the basis of natural law.

Every phenomenon is a manifestation of energy changes.

Progress of research would seem to indicate that the behavior of all substances is reducible to the laws of chemistry and physics.

There is an essentially common electrical basis of matter.

Space is vast.

The positions of astronomical bodies are regulated and all matter affected by attractional forces.

The earth seems very old when its age is measured in the ordinary units of time, but its origin is only a recent event in the seemingly endless stretch of time.

The sun largely determines conditions on the earth; variation in its radiant energy producing changes which have sometimes had profound effects.

The earth's position and movements determine most of the regularly recurring phenomena of nature.

Life ordinarily comes from existing life, and is passed on from generation to generation little changed by its environment.

Life is maintained in all living things through physiological processes carried on by the exceedingly complex protoplasmic units, any great deviation from optimum conditions for functioning resulting in ill health or death.

Higher plants and animals consist of coordinated and specialized units of life.

Continued existence on the earth is made possible through cycles involving recurring synthesis and decomposition.

Sexual reproduction involves recombination of characters which are ordinarily transmitted in mathematical proportion, thereby introducing an element of change in the stream of life which may be directed toward desired ends.

Natural forces bring about continual evolution of the earth and the conditions for existence.

Species survive which in their evolution develop characteristics suited to the conditions for existence.

Through development of a more complex nervous system, man is able to compete with other forms of life which excel him in many respects, and to achieve a limited control over existence.

There is a vast amount of interdependence among living things and a struggle for existence which tends to maintain a balance between the various forms of life.

The realization of the inherent possibilities of each living thing is dependent upon a complex of environmental factors.

The interactions of plants and animals with their environment tend to bring about succession toward stable communities in accord with the climate.

The ernormous use made of the basic truths which have been discovered, demonstrates the importance of fundamental research.

3. *To lead to utilization of knowledge and experiences in coping with the forces of nature and in making use of the fruits of discovery and invention.* The amount of directly helpful knowledge to be acquired and utilized is very great, and it is increasing rapidly. This information concerns most of the ordinary affairs of life. Some of it has to do with maintaining health. The tremendous increase in accidents has made training for safety almost equally important. Science for the consumer is beginning to receive deserved recognition. Many of the products offered for sale are useless and even dangerous encumbrances, which enrich only the producer and sales organizations. Some are of great value in freeing human energy for intellectual and social existence. Man does not hold the unquestioned supremacy on the earth with which the unscientific mind is wont to credit him. He needs to know how to combat the forms of life which would otherwise negate much of his effort and endanger his existence, and he should be able to utilize other species capable of aiding him. He must learn how to employ certain principles and forces, and to get the best possible service out of his machines and devices. These and many other utilitarian outcomes constitute one of the important major aims in science teaching. The knowledge should be gained in a way that will be likely to result in its utilization.

4. *To develop social attitudes and appreciations.* We are coming to realize that education must be directed toward social outcomes. Many of the principles of science have important applications to the public welfare. So long as we adhere strictly to scientific truth, there can hardly be any reasonable objection to directing science training toward cooperative action in the interests of society. While this is the aim of the social studies, the fields of instructions are not separate and unrelated. The tendency at present is toward integration. It is our duty to contribute to this social aim wherever possible.

One of the fields in which we can make a social contribution is that of conservation. Stream pollution has become a public menace. Forests have all but disappeared. At the same time, fires have increased until there is no adequate reproduction. The progress of what we have called "civilization" has left few natural remnants of primitive America. Belated efforts are being made to set aside some of the few remaining areas. Many forms of wild life are approaching extinction. Due to unscientific management, soil erosion has progressed to a rather alarming stage. We are using within a short period of time mineral and other resources which represent the product of geological ages.

There is a social as well as a personal side to health and safety training. They are still regarded too much as personal matters. The increased use of discovery and invention in the service of mankind deserves more consideration. Ideals of contribution and service rather than accumulation can be fostered through study of the lives of scientists. The scientific approach to the problems of marriage, reproduction, and race improvement is of great social value. There is hardly a social problem to which science teaching cannot make a contribution.

5. *To cultivate scientific attitudes and habits of procedure.* There is a tendency to confuse this aim with an attempt to make scientific specialists of our pupils. This confusion shows lack of understanding of the greatest contribution of science and of science education, which is clearly the dependence upon conclusions carefully arrived at on the basis of the available evidence, rather than upon hearsay, propaganda, and tradition. This habit of mind is of greatest importance to every individual. Science is more than classified knowledge. It is a way of life. The reactions of persons all about us furnish innumerable examples of the need for this training. The unquestioning following of traditional procedures, the blind faith in

miraculous cures, the acceptance of printed statements which run counter to the individual's repeated experience, the tendency to accept as truth and to repeat what is pure hearsay and gossip, the willingness to accept the statements of others in matters which can easily be verified, the failure to distinguish between methods of arriving at "truth," and the prejudiced and closed-minded attitudes toward new ideas constitute abundant evidence that this aim is not being achieved. There is nothing vague about this aim. It is one of the very definite goals toward which science instruction at all levels should be directed. Instruction in other fields can contribute to this habit of mind, but science offers a particularly favorable opportunity for its development. Accomplishment of this aim is dependent upon suitable methods of instruction. It can never be achieved by blind acceptance of the statements of the teacher or of the printed page. It is necessary to provide practice in the attitudes and methods of thought and procedure we wish to become habitual. There is considerable evidence that our attitudes are specific. It is, therefore, desirable to develop scientific attitudes and procedures in a wide range of life situations.

CRITERIA FOR THE SELECTION OF SCIENCE TEACHING MATERIALS*

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This article is abstracted from the complete report of a study concerned with (a) the determination of the standards, factors, or criteria which control the selection of special equipment, supplies, apparatus, specimens, and other materials used in the teaching of general science, biology, chemistry, and physics in grades seven to twelve of public schools and (b) the evaluation of these criteria. The study does not attempt the formation of minimum or other lists of equipment, apparatus, and supplies. Rather, it contributes to the determination and evaluation of criteria for the selection of items for inclusion on such lists of science teaching materials. The selection of books and furniture and the choice of pencils, paper, and other supplies not peculiar to instruction in science are not included in the problem.

The significance of a study of criteria for determining the selection of science teaching materials seems evident because a rather careful study of the published state, city, and other lists of recommended or required teaching materials and an examination of the literature of science teaching do not reveal any printed statements of such citeria or their derivation. The investigator read carefully more than one hundred courses of study and lists of teaching materials in science without finding any statement of the standards or criteria by which the items comprising the lists or the laboratory experiences contained in the courses of study were chosen or what factors controlled their choice. In the references cited in the bibliography by Pieper[1] of over eight hundred research studies in science education, no statements of such criteria were found. Likewise in Curtis'[2] digests of investigations in the

* An abstract of a dissertation submitted in partial fulfillment for the doctorate degree in the School of Education, New York University, 1935.

[1] Pieper, C. J. "Research Studies Related to the Teaching of Science." *Science Education* 16: 55–65, 140–148, 233–237, 297–302; October, December, 1931, February, April, 1932, and 17: 138–150; April, 1933.

[2] Curtis, F. D. *A Digest of Investigations in the Teaching of Science in the Elementary and Secondary Schools.* Philadelphia: P. Blakiston's Son and Company, 1926. 341 p.

———. *Second Digest of Investigations in the Teaching of Science.* Philadelphia: P. Blakiston's Son and Company, 1931. 424 p.

teaching of science, no record was found of any criteria for the selection of teaching materials in science.

Although study of the literature relating to instruction in science which was available to the investigator did not reveal any printed criteria, it seemed evident that there must exist certain functioning criteria for the selection of science teaching materials, which criteria have determined the choices of experiments by authors of texts, laboratory manuals, courses of study, committee reports, and other lists of laboratory experiences, and the choices of items of equipment, apparatus, and supplies by the individuals and committees responsible for the formulation of city, state, and other lists of required or recommended teaching materials. That these criteria exist but suggest problems of determination and evaluation is attested by the following quotation from Holy and Sutton, in which the authors refer to their study as

> . . . a cooperative project . . . since the contents are based on the judgments of science teachers and supervisors in thirty-five states . . . The more logical method of securing lists of science apparatus would be to determine first the experiments necessary to attain the objectives in each science, but since science teachers do not yet agree on the objectives this simple, but logical, method could not be followed.[3]

As will be shown later, even this method, simple and logical though it is, would not result in a perfect list of science teaching materials, because other criteria than those which satisfy the objectives of science teaching also influence the selection of science apparatus, equipment, and supplies.

In the preparation of a tentative, inclusive list of criteria to be used in later evaluations and comparisons, an attempt was made to derive from the literature relating to science instruction a statement of the standards, factors, or criteria which do or should control the selection of science teaching materials. No direct statements of such criteria were found, and no indirect statements except the implied criterion of the objectives of science instruction. This rather obvious implication that the equipment, apparatus, and supplies, through the laboratory experiences which they provide, should contribute to the attainment of the objectives of science instruction is in itself inadequate as a guide in the selection of science teaching materials. This becomes evident when one recalls that the objectives of science teaching may be stated in an inclusive, indefinite summary like that of the Thirty-first Yearbook Committee:[4] "It recognizes the objectives of science teaching to be the functional understanding of the major generalizations of science and the development of associated scientific attitudes." Or the objectives may include such a detailed list of statements or topics as Persing's[5] list of 376 objectives of a single science, biology.

A second and more successful method used in the derivation of criteria was correspondence with one hundred eight specialists in science education selected from the editorial staff of Science Education; authors of certain articles on science laboratories, laboratory methods, objectives, experiments, teaching materials, and related subjects listed in the Education Index from January, 1929, to January, 1933; chairmen and advisors of course of study committees in science; state and city supervisors of science; manufacturers of science equipment, apparatus, and supplies, and authors of secondary school science textbooks and laboratory manuals.

[3] Holy T. C., and Sutton, D. H. *List of Essential Apparatus for Use in High-School Sciences.* Columbus, Ohio: Bureau of Educational Research, Ohio State University. Monograph Number 12, 1931. 32 p.

[4] National Society for the Study of Educational *Thirty-first Yearbook,* Part I, "A Program for Teaching Science." Bloomington, Illinois: Public School Publishing Company, 1932. 270 p.

[5] Persing, E. C. "Present Objectives in Biology." *Science Education* 17: 24–34; February, 1933.

One hundred fifty-one letters were sent to members of these groups; one hundred eight replies were received, and from these replies was derived the tentative list of criteria contained in Table I.

TABLE I

Tentative Lists of Criteria for the Selection of Science Teaching Materials

1. Contribution to the attainment of the objectives of science instruction.
2. Suitability and significance to the principle under discussion.
3. Significance of the principle under discussion.
4. Enrollment of science classes compared to that of other classes.
5. Funds available for the purchase of science materials.
6. Contribution to the understanding of the scientific method.
7. Whether price is commensurate with the learning products attainable through use of the item.
8. Contribution to the attainment of scientific attitudes and appreciations.
9. Contribution to pupils' interests in the subject.
10. Requirements of the course of study.
11. Type of course, as vocational compared with college entrance.
12. Type of laboratory work, as demonstration compared with individual experimentation.
13. Number of different courses in science in the school.
14. Methods of organization and presentation of subject matter.
15. The extent of use of visual aids.
16. The experiments which have been selected for use.
17. Location of the school, *i.e.*, opportunity to study scientific phenomena at primary sources.
18. Ease of improvisation of substitute apparatus.
19. Frequency of use of the teaching material.
20. Ease of assembling and ready availability when needed.
21. Teachers' ability and willingness to use the apparatus.
22. Relation of the apparatus to proable experiences of pupils' lives.
23. Suitability to pupils' needs, *i.e.*, not needlessly complicated or fancy.
24. Economy of time and energy in teaching a concept.
25. Teachability of the concept without experimentation.
26. Rate of depreciation of the article.
27. Ease of caring for and storing the article.
28. Economy of time and energy of the teacher.

After securing the above tentative list of criteria for the selection of science teaching materials, an attempt was made to accumulate an authoritative consensus concerning whether the criteria were, individually, valid or invalid, and whether each criterion should function in all or less than all selection of items of science teaching materials. To this end a second mailing list was prepared, comprising the names of sixty-five of the science teaching specialists who answered in detail the first inquiry and additional names to make a total of one hundred twenty. This second mailing list included thirty-three members of the National Association for Research in Science Teaching.

Eighty complete replies were received from correspondence with the individuals included on this second mailing list, to each of whom had been mailed a request that judgments be expressed on the criteria (listed in Table I) proposed on an enclosed sheet, and that comments be made on the criteria. It was asked that judgments of each criterion be indicated by a three-category classification as (1) necessary or essential to wise selection of science teaching materials, (2) advisable though not always significant, and (3) invalid or not sufficiently important to deserve consideration in the selection of science teaching materials.

Table II presents for each criterion the judgments of the specialists in terms of the per cents of the total number of specialists equivalent to the numbers of specialists indicating each judgment or omitting judgment. The column "Criterion Number" refers to the criteria as numbered in Table I. Table II should be read as follows: Criterion Number 1, Contribution to the attainment of the objectives of science in-

struction, was judged "necessary" by 93.8 per cent of the specialists, "advisable" by 2.5 per cent of the specialists, and "not valid" by 2.5 per cent of the specialists, and 1.3 per cent of the specialists omitted judgment of this criterion.

by ninety or more than ninety per cent of the specialists. Criteria so judged are numbers 1, 2, 5, 9, 10, 12, 16, 18, 19, 20, 23, 24, and 28. The least significant criteria in the light of these data were numbers 4, 11, 13, and 21, each of which was

TABLE II

JUDGMENTS OF EIGHTY SELECTED SPECIALISTS IN SCIENCE TEACHING ON TWENTY-EIGHT CRITERIA IN PER CENTS

Criterion Number	*Per Cent of Judgments of "Necessary"*	*Per Cent of Judgments of "Advisable"*	*Per Cent of Judgments of "Not valid"*	*Per Cent of Omitted Judgments*
1	93.8	2.5	2.5	1.3
2	81.3	15.0	2.5	1.3
3	56.3	30.0	7.5	6.3
4	11.3	41.3	43.8	3.8
5	73.8	22.5	1.3	2.5
6	52.5	32.5	11.3	3.8
7	42.5	45.0	10.0	2.5
8	56.3	31.3	11.3	1.3
9	57.5	37.5	2.5	2.5
10	62.5	30.0	7.5	0.0
11	37.5	37.5	23.8	1.3
12	81.3	16.3	2.5	0.0
13	30.0	37.5	30.0	2.5
14	51.3	37.5	5.0	6.3
15	22.5	57.5	12.5	7.5
16	80.0	13.8	5.0	1.3
17	27.5	60.0	12.5	0.0
18	37.5	52.5	8.8	1.3
19	42.5	47.5	8.8	1.3
20	41.3	48.8	7.5	2.5
21	41.3	36.3	21.3	1.3
22	32.5	56.3	10.0	1.3
23	65.0	26.3	5.0	3.8
24	52.5	42.5	5.0	0.0
25	33.8	52.5	8.8	5.0
26	28.8	52.5	16.3	2.5
27	22.5	57.5	17.5	2.5
28	46.3	50.0	3.8	0.0

It will be noted from Table II that four criteria, numbers 1, 2, 12, and 16, were judged "necessary" by eighty or more than eighty per cent of the specialists, and that seven criteria, numbers 1, 2, 5, 10, 12, 16, and 23, were rated "necessary" by sixty or more than sixty per cent of the specialists. If criteria judged either "necessary" or "advisable" are considered, it will be seen that thirteen, or nearly half, of the criteria were judged either "necessary" or "advisable" judged "not valid" by twenty or more than twenty per cent of the specialists.

The next step in this investigation was an attempt to consider each criterion in terms of relevant principles and practices of science teaching, derived from the literature on science teaching, applicable to those criteria which are related to the aspects of science education which are treated in available literature. Through this step it became evident that certain of the criteria may be classified together be-

cause they may be applied with few data other than those involved in general familiarity with the local teaching situation, such as course of study data, number and preparation of teachers, type of laboratory work, funds available for science materials, size of class and storage rooms, etc. Such criteria are (Table I) numbers 4, 5, 10, 13, 16, 17, 19, 21, and 27, and, in a superficial but useful way, numbers 11, 12, 14, 15, 20, 26, and 28. These criteria can be applied successfully by the science teacher, or, with the exception of the last seven criteria, by administrators without training or experience in science teaching. Some of these criteria, notably numbers 4, 5, 10, 13, 16, 17, and 19, seem well adapted to objective application.

Another group of criteria involves unsolved or partially solved problems of science instruction, and should, if used at all, be applied in the light of research reported in the publications and of authoritative treatises on science education. Such criteria can not be applied successfully, at the present time, in an objective way. They require the services of an individual or a group who can consider each proposed item of science teaching materials in terms of the satisfaction of any given criterion, the criterion being interpreted by the individual or group in the light of the published researches and authoritative treatises on the aspects of science teaching which are involved in the criterion. Criteria belonging in this classification are numbers 1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16, 18, 22, 23, 24, and 25. None of these criteria is well adapted to objective use.

A third group of criteria may be considered apart from the other criteria, not on the basis of the degree of difficulty involved in their application, but because of their being somewhat dependent upon or somewhat conditioned by Criterion Number 1. Such criteria are numbers 3, 6, 8, 10, 12, 14, 15, 16, and 22. All of these criteria have direct interrelationships with the objectives of science instruction involved in the application of Criterion Number 1.

The actual use of certain criteria involves relationships between the present study and a number of major problems of science instruction. This is well illustrated in the application of Criterion Number 1. This criterion was considered "necessary" by nearly 94 per cent of the judges, and apparently was considered by them to be a functional, usable criterion, despite the disagreement commonly found concerning what should be the objectives of science education. Assuming, however, a list of objectives which are expressive of a sound philosophy of science education, the educator will still be confronted with problems, involving less-explored fields than the determination of objectives. These questions will have to do with the relative importance of the objectives, the learning experiences which contribute to the attainment of each objective, the extent to which common learning experiences contribute, the adaptability of the learning experiences to the different age and grade levels, and a determination of which learning experiences may best be laboratory experiences. If these and certain other problems were solved, the application of Criterion Number 1 would probably become a comparatively easy, objective process. In the absence of such data, the application of this criterion must depend upon subjective judgments of the degrees to which the various items of teaching materials satisfy this criterion. Such judgments call for a basic understanding of the major problems of science education and of the contributions which published research has given to these major problems. For this reason, conclusion number 11, below, seems especially significant. This seems vital, because the great body of published research, while it does not contain solutions which are final for the problems of science instruction which are related to the applications of the criteria treated in this study, does

contain much valuable pertinent data which help to build up the apperceptive background which should condition the application of these criteria.

The following conclusions seem indicated as a result of this study:

1. There are no published lists of criteria for the selection of science teaching materials.
2. Criteria, standards, or factors do exist which control the selection of science teaching materials.
3. Opinions differ concerning what criteria should control the selection of science teaching materials.
4. The list of twenty-eight criteria herein reported seems to be an inclusive list.
5. The following seven criteria were sufficiently important to be judged "necessary" by sixty or more than sixty per cent of the specialists in science education reached through this study:
   (1) Contribution to the attainment of the objectives of science instruction.
   (2) Suitability and significance to the principle under discussion.
   (3) Type of laboratory work, as demonstration compared with individual experimentation.
   (4) The experiments which have been selected for use.
   (5) Funds available for purchasing science materials.
   (6) Suitability to pupils' needs, *i.e.*, not needlessly complicated or fancy.
   (7) Requirements of the course of study.
6. The least significant criteria, all of which were judged "not valid" by twenty or more than twenty per cent of the specialists in science education reached through this study were:
   (1) Enrollment of science classes compared with that of other classes.
   (2) Number of different courses in science in the school.
   (3) Type of course, as vocational compared with college entrance.
   (4) Teachers' ability and willingness to use the apparatus.
7. Certain of these twenty-eight criteria may be applied in the light of pertinent information found in published research.
8. Certain of these twenty-eight criteria can not at the present time be applied in the light of pertinent information found in published research, but can be used only on the basis of subjective judgment of the degree to which any specific item of teaching materials will satisfy a given criterion.
9. The selection of science teaching materials should be made by someone familiar with the local course of study, with its objectives, and with the principles of selection and organization of subject matter used in its preparation.
10. More research than is now available is needed or certain important problems in science teaching in order to make possible the most successful application of each of the criteria herein recorded to actual cases of selection of science teaching materials.
11. It is important that the person or persons responsible for the selection of science teaching materials be familiar with published research relating to science education.

The last conclusion reported above, number 11, seems to the investigator to be of greatest importance among these conclusions. Nearly every criterion herein reported requires, in its successful application to actual problems of selection of teaching materials, a subjective determination of the degree to which an item of teaching materials satisfies a given criterion. For this reason, conclusion number 11 seems especially important.

HOW A NATIONAL COUNCIL OF SCIENCE TEACHERS COULD ENCOURAGE, PROMOTE, CORRELATE AND DISTRIBUTE THE RESULTS OF RESEARCH IN SCIENCE TEACHING*

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Let us look very briefly at the situation in which research in science teaching finds itself at present. The possibility of the formation of a national organization of science teachers has, as I understand it, been under consideration for a good many years. In the midst of this discussion, concerning the formation of a national organization of science teachers, there materialized at Boston, in 1928, a new organization of a somewhat different type from that which had seemed to be uppermost for some years in the minds of many leaders in science education. This new organization, which has been functioning since 1928, is the National Association for Research in Science Teaching. This research organization has, since its formation, carried on, to some extent, the kinds of activities in connection with research that are enumerated in the title of this paper. It has, in the meantime, adopted the journal, SCIENCE EDUCATION, as its official organ.

There are some principles which, I think, might help us in our consideration of this problem. In the first place, we need to realize that the very essence of our civilization is specialization on the one hand and cooperation on the other. When we have organisms made up of highly specialized parts, we must have stimulating and coordinating mechanisms. There must be centers of dominance and centers of subordination. Whenever the activities of one unit of a complex organism influence other units, there must be dominating activity—areas that send out impulses of such a nature that the activities of the individual parts, in response to these impulses, will be coordinated for the good of the entire organism. The function, or functions, of each organism or organization needs to be very clearly defined. I am not in favor of forming an organization and then determining what it is to do. You have a very dangerous situation when you get an organization that feels it should do something but does not know just what. The boundaries within which an organization may feel free to exert its initiative should be definitely fixed. The proper types of activities in connection with research in science teaching, appropriate for a national council of science teachers would, it seems to me, be: (1) stimulating activities; (2) correlating activities; (3) distributing activities, (4) evaluating activities.

Any complex organism needs one dominating activity center to which all other activity centers are more or less subordinate. What stimulating activities might a national council of science teachers perform? It could, in the first place, be a great stimulus to the various research centers now at work on problems in science education. All of these various centers would have an opportunity to report their research activities to a meeting at which would be assembled science education leaders from all parts of the country. It is quite conceivable that individuals and research centers might do their reporting to the National Association for Research in Science Teaching and that the Association might in turn report to the Council a summary of the activities in the field of research. At any rate, such a report to a national group would certainly promote national interest in research, advertise the National Association for Research in Science Teaching, and tend to stimulate more research. In this way,

* Presented at the meeting of Science Teachers with the American Association for the Advancement of Science on December 29, 1934, in Pittsburgh, Pennsylvania.

problems for study would come in from all parts of the country. Research centers need in their total stimulus all the factors which are rightfully part of the whole. It would seem to be more appropriate for a field secretary of a national group to do much of this stimulating than for those who are actually doing the research.

In the second place, such a national organization could stimulate individual teachers all over the country to put the findings of research into operation. In addition to distributing research, some one needs to persuade teachers to use the results obtained from it. At present many of the ordinary classroom teachers are not greatly excited about the results of our research. School executives also need to be shown the value of research results and the importance of putting these results into practice.

The correlating activities of such a national council were, according to Carpenter's study, ranked sixth in eleven possible functions by 152 people to whom he sent a questionnaire.[1] This is the activity that brings about coordination and cooperation. Such an organization as is here proposed can, with the entire science program in mind, see the points at which more work needs to be done and then try to fill in the vacant spots in the program. Such an organization should receive reports of all research activities and should be able to coordinate and correlate the various reports and show not only the relationship between the different reports but also just what each report contributes to the entire science program.

According to Carpenter's study, the function of a national organization to distribute published material was ranked third among eleven possible proposed functions by 152 persons. Such an organization would be a depository for all published research as well as a collector of research not published. It could publish this research material not otherwise available. It could publish the results of the correlation of various research studies. Through its influence it is quite probable that a more balanced publication of research materials would be accomplished. There are objectives of science teaching on various levels. It follows that research activities must be carried on at various levels also.

Such an organization need not depend entirely upon published material for the distribution of the results of research. Delegates to the meetings of a national organization can, after discussing various regional problems, take the results of these discussions back to the local organizations in a way that will make them useful and profitable.

There is a pressing need at present to get the fruits of research into practical operation in the classrooms of the country. At present, the results of investigations go to a very few of the people who are actually doing the teaching. The best of these research products should be organized and distributed throughout the country. The results must not only be distributed but the classroom teacher must be shown the importance of this material and how and why it should be put into practice. It has been well said that actual practice in the schools is a generation behind the recommendations of research already made. The regular classroom teacher must not only know these results of research but must be induced to modify the science materials and procedures in conformity with these recommendations. They must see how the results of research are applicable to the settlement of individual and social problems. Science people need to be on their guard at this particular point or the social science people, in this time of social and economic stress, will steal the thunder of the natural scientist. The question here is whether it is better to trust the social science teachers to give the science necessary in the solution of social problems or whether it will be better to entrust to the

[1] An unpublished report of a study by H. A. Carpenter, Rochester Public Schools, Rochester, New York.

natural science people the matter of giving at least enough social science to show the significance of natural science material in the solution of many social problems. Science needs to make more progress with the public. Such a national organization as is being discussed could help in furthering this needed progress.

Finally such a national organization could perform a service in helping to interpret and evaluate research. Research people are not always best prepared to interpret the results of their own research. This is true at present, I think, in the matter of interpreting results of research and planning research projects, in the light of the fundamental facts of biology concerning the explanation of behavior. If an explanation of behavior of organisms somewhat different from the one now generally accepted by those at work in the field of science education were made some of the interpretations of present day research would have to be changed. Certainly, most of us who try to do research, are undoubtedly not fitted to evaluate our own research in comparison with the research of others. By allowing the entire science profession, through its representatives in a national organization, to do the evaluating we shall be better able to see each piece of research in the proper perspective.

Now let us consider what will be necessary to have such an organization function in some such way as has been indicated. Sufficient funds must be provided to employ a paid secretary. This secretary must be a strong and recognized leader of a type that would deserve a salary of approximately $5,000.00 per year. In order that such a secretary may print and distribute the material that will need to be distributed, to carry on the correspondence that will be necessary in his correlating function, and to travel in attending meetings of the various organizations whose work he is trying to coordinate, he will need, in addition to his salary, a fund of at least $5,000.00 a year. This would make necessary a sum of $10,000.00 per year. In order to assure such a program for a five-year period it would seem that $50,000.00 would be needed. With this amount available such a national organization could, I think, make a real contribution. Without this amount it would seem hardly worth while to start the program.

The writer has consulted various members of the American Association for Research in Science Teaching and has used some of the ideas received. Since the ideas were not given with the understanding that they were to be used as quotations, and since, in a few cases, requests were made by members that they not be quoted unless they were able to check the exact quotation, the writer has, in some cases, used as his own, practically the same ideas that were expressed to him by others.

THE TEACHING OF CONSERVATION IN HIGH-SCHOOL BIOLOGY

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The conservation of our natural wild animal life is a phase of biology which has seldom been stressed in the schools. As a nation we have indifferently watched the annihilation of beast and bird, thinking that there was no need for alarm, that unusual conditions have brought about this change, which was, of course, only temporary. A little sober thought is bringing us to our senses, however, and we now realize that time can no longer be wasted if we are to save much of what yet remains.

North America, in 1844, witnessed the extinction of the Great Auk; in 1875 the last of the Labrador Ducks; in 1890 the disappearance of the Carolina Paroquet; in 1914 the end of the Passenger Pigeon; in 1926 the last Eskimo Curlew was killed; and in 1932 the only surviving Heath Hen died. Today science holds little or no hope for the Ivory-billed Woodpecker, the Trumpeter Swan, the Whooping Crane, the California Condor, and several other species.

The California Grizzly is now extinct, as is also the Arizona Elk. Bears are so rapidly disappearing, except in certain localities, that many scientists and sportsmen feel that all grizzlies will disappear from the United States within a fairly short time unless more protection is given them. Antelope have been so persistently killed that today most of the remaining herds must be rigidly protected. Mountain sheep and mountain goats are now barely able to hold their own in spite of all the protection given them. Yet we hear men argue that seasons should be opened on these animals "to keep them from inbreeding." Caribou no longer inhabit the United States and the few remaining moose receive protection. Many authorities believe that the twentieth century is witnessing the total disappearance of large game animals.

Waterfowl have faired no better. Where once billions of waterfowl bred and annually migrated across this country, the Government reported in 1934 that there are not enough left to adequately utilize available breeding grounds. The birds have been lured to death by every trick man has been able to devise. In many places the shooting of ducks has passed from the category of sport to that of slaughter. Millions of dollars are now being spent in an attempt to save the remaining birds.

Through misunderstanding and the desire to kill, our hawks and owls have been reduced alarmingly over the country. In some states they have almost reached the vanishing point. Our national bird, the Bald Eagle, that we so proudly display as the symbol of freedom and an emblem of justice, receives so little protection that it is rapidly disappearing from many of our states. Some species of hawks which are considered harmful are now receiving consideration and even protection for fear they may be forever lost. Through education men are slowly learning that a vital mistake is made when birds of prey are killed. Hawk Mountain in Pennsylvania has been made a sanctuary for the raptores.

The damage to game fish charged against birds by men, is almost always exaggerated. Some explanation is necessary for the shortage of game fish, so any fish-eating bird or beast is looked upon as an intolerable rival that must be promptly controlled or exterminated. Few investigations have been made regarding the true diet of fish-eating birds and the few facts scientists have published are seldom read. Many men feel that no investigation is necessary,

for if the birds eat fish, that is justification enough for shooting them.

We in biology, who have had the opportunity of opening the students' hearts to a love of the out-of-doors, and of teaching true relationships of animals to each other and to man, have been more interested in teaching from dead specimens than about of living forms. We were taught cold biological facts during our schooling and have come to feel that these are the important things in a course that is supposed to study life. Only within recent years has there been a tendency on the part of biologists to include in high-school texts units of work which will create an appreciation of our wild life. With this appreciation will come a truer meaning of conservation.

I have found in my classes that any work on conservation, be it conservation of birds, mammals, fish, trees or flowers, always stimulates keener interest, awakens enthusiasm and creates a liking for this field of science. Few students taking biology will long remember or seldom use many of the scientific facts we require them to learn. Practically all of the students, however, have a keen desire to know the common habits of the more common animals. The saving of fast diminishing forms has a special appeal to most students. Abuses to wild life are quickly recognized and remedies, both practical and impractical, are offered. When a new unit in conservation is introduced a large percentage of the students show a desire to contribute to the work, for here is something that fits into their everyday life.

While I would not be so dogmatic as to prescribe that all biology teachers should delve deeply into a study of conservation, yet I would suggest that any teacher, who finds his or her course so routined that "new blood needs to be injected into its veins," should introduce work involving the saving of the life we are studying. Not only will classes take a new interest in the biology course, but the students will become acquainted with a part of biology that will be retained long after most facts are forgotten. And the great out-of-doors with the many forms of life we are studying will receive untold aid from the new constructive attitude of the developing citizens.

ANNOUNCEMENT

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Clarence M. Pruitt, *Business Manager,*
Colorado State College of Education,
Greeley, Colorado

HIGH-SCHOOL SCIENCE—A FOUNDATION FOR SCIENCE COURSES IN COLLEGE*

RALPH E. HORTON

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I have here three clippings which suggest some of the perplexities involved in the articulation of high-school and college sciences. The first is a clipping from the *New York Times* reporting the address of Professor Ross A. Baker, Chairman of the Division of Chemical Education of the American Chemical Society, at a meeting of the society in Cleveland during September, 1934. It reads:

VITAL CHANGES ARE PLANNED IN ELEMENTARY CHEMISTRY

Professor Baker announces that elementary chemistry will be revolutionized in a new program of science instruction to be developed by the division of chemical education of the American Chemical Society. Elementary applications of the quantum theory may be introduced into first year courses.

This suggests the problem of content. What topics shall be included and what omitted in the introductory science courses at the secondary school level?

The second is a clipping from the *New York Times* of November 26, 1934, which reads in part:

THREE WOMEN'S COLLEGES REQUIRE LESS LATIN

Mount Holyoke, Smith and Wellesley Colleges have announced changes in the subjects required for entrance, effective with classes entering in September, 1936. Mount Holyoke still recommends that Latin or Greek be presented, but ceases to require them,—Smith and Mount Holyoke have reduced the number of units required in mathematics from three to two. Smith still requires three units from the mathematical-scientific group but will permit the third unit to be in sciences.

This suggests the problem of the parity of science and other entrance subjects.

The third is an excerpt from an address by John Dewey. He says:

> The obligations incumbent upon science cannot be met until its representatives cease to be content with having a multiplicity of courses in various sciences represented in the schools, and devote even more energy than was spent in getting a place for science in the curriculum, to seeing to it that the sciences which are taught are themselves more concerned about creating a certain *mental attitude* than they are about purveying a fixed body of information or about preparing a small number of persons for further specialized pursuit of some particular science.[1]

This suggests two problems. First, what should be the aims of science instruction—information or training in mental habits? Second, for whom are the science courses in high schools to be designed?

In the few minutes at my disposal, I can sketch only briefly some of the bearings of the problem and suggest some lines of attack. The thesis to which my inquiry has led is that the problem of articulation of high-school and college science cannot be solved apart from the larger national program of education. It ought to be kept in mind also that even the thesis is based on assumptions—by no means accepted—that the colleges can justify their own programs.

We are in our present quandary, largely, perhaps, because of our failure to provide a broad program of science from kindergarten to college which might set up goals and suggest the contributory means of arriving at these goals. Without listening to a long recital of history, you will probably agree that our present science curriculum, as well as the content of courses, has resulted from a sort of father-to-son tradition rather than from a careful long-range plan.

Science instruction both in colleges and academies (the first secondary schools) had its origin in lecture courses in natural history. Among the colleges, Harvard had such a course in 1690. Yale, Princeton, and Columbia all offered lecture courses in

* Paper read at the meeting of the Association of Science Teachers of the Middle States at Atlantic City, December 1, 1934.

[1] Dewey, John. "The Supreme Intellectual Obligation." *Science* n.s., 79: 240–243; March 16, 1934.

natural history early in the eighteenth century. In secondary schools, science has had a place since their foundation. The development of courses in high schools can be traced to the colleges. Their content at first was prescribed by college teachers, first because they wrote the textbooks and second because when they became high-school teachers they transplanted to their own classes the subject matter of the college courses. However, since many points of view came to be represented, no uniformity in content or method can be said to have prevailed during the early period. When certain sciences became acceptable to colleges for entrance, better definitions of what science courses should be naturally followed. Probably the College Entrance Board has been the most effective agency at work to raise the general level of science instruction in the secondary schools. At the same time, content and practices have not responded to efforts at standardization. Even in New York State, where a State Board of Regents has prescribed syllabi, has required definite laboratory work, and has administered state-wide uniform examinations, the practices are by no means uniform. Today, then, we find that science instruction in secondary schools is still following traditional lines, without generally accepted goals, without sequence, and without a program for articulation with college science.

We have labels for courses such as general science, biology, physics and chemistry, physiography, geology, botany and others. These labels do not represent equivalent courses, in aim, in content or in difficulty even in the same school system, to say nothing of a state-wide or national standard.

Let us consider some of the disconcerting perplexities of the science situation as disclosed by recent studies. First, let us look at the situation in the colleges. N. M. Grier[2] made a study of enrollment in sciences in thirty-seven colleges and universities in 1926. It was found that the percentage of the total number of students enrolled in higher institutions of learning who are taking courses in natural science is not increasing.

This may surprise some of us. It does not mean that no more students are taking science courses but that the percentage of all students enrolled in science, from year to year, is practically constant. Grier says, "The first year of biological, chemical and physical science is becoming increasingly popular with students, but for some reason, within or without their control, these departments fail to hold students for advanced work in them."

Another study by Van de Voort,[3] now of the University of Delaware, gives evidence of the very great variation in titles of science courses in colleges. Ninety institutions were surveyed. In these, 612 courses in chemistry are offered under 66 different titles; in physics, 438 courses under 105 different titles, and in biological sciences, 736 courses under 144 titles. These were all on the college level although selected primarily from teacher-training institutions. The same lack of uniformity in naming or describing courses prevails in the colleges generally, as a casual (or careful) study of college catalogs will reveal. While this constitutes a part of the picture and the confusion, we may not infer that the practice is avoidable or necessarily undesirable.

Let us pass on to some of the other perplexities of the present relationship between college science and secondary-school science. The most serious one, probably, is the presence in secondary schools of a large number of students who do not desire or propose to go to college. Some of these students are possessed of ability to do science work equal to candidates for college. Others are unable to do so. Moreover, a

[2] Grier, N. M. "A Preliminary Report on the Progress and Encouragement of Science Instruction in American Colleges and Universities." *School Science and Mathematics* 26: 753–764; 872–881; 931–940; 1926.

[3] Van de Voort, A. M. *The Teaching of Science in Normal Schools and Teachers Colleges.* Contribution to Education No. 287. New York: Bureau of Publications, Teachers College, Columbia University, 1927.

greater number and a larger percentage of our secondary-school graduates now apply for admission to college than was the case twenty years ago. The present period involves the anomaly of a larger number who are unable to find remunerative work and who turn to college as a place to spend four years . . . and at the same time, the economic inability of many of these aspirants to meet the financial requirements. The perplexity here is whether or not to give different courses for those going to college and those not going to college.

This perplexity is related to another one: is there such a thing as "pandemic" science? That is, can we make courses which are fitted to every one's needs at the high-school level? We see on the one hand college preparatory courses which all students, both college and non-college, now take. On the other hand, it is proposed that courses be devised which are based on the assumed present needs of boys and girls at the high-school level regardless of whether or not they propose to enter college. In the one case it is alleged we do injustice to the non-college student who is obliged to take technical topics which function only in study of further science. In the latter case the student preparing for college will be deprived of the groundwork in mathematical relations and organized systematic science that is supposed to furnish what the college teachers desire as preparation. Dewey's point of view previously quoted would seem to relate to this problem.

Again, we have some evidence that the science work done at the secondary-school level makes very little difference with success in college science. Two reports may be cited. Noll,[4] at the University of Minnesota made an extensive study of the teaching of inorganic chemistry. Comparison of two groups, one having had no chemistry in the high school and the other having had chemistry in the high school, showed a very significant superiority for the latter group at the beginning of the college course but no such superority after two quarters of very similar instruction in general inorganic chemistry. These results seem to confirm the findings of Powers[5] in his study of success of college freshman in chemistry in 1920.

Another aspect of the matter is that there is no definite science course for which high-school science may prepare. In some colleges the first course in chemistry is practically a repetition of the topics—more extended probably—which were taken in elementary chemistry in high school. In other subjects such as physics the college course has very little relation to the high-school course. Koos[6] reports as follows:

> Although there are some differences between the high school and first college courses in chemistry, they are remarkably alike. . . . If a student takes a course in general inorganic chemistry in college after having a high school course, which is often done, he is repeating almost all of it.

Hurd[7] made a study of physics and reports as follows:

> While the high school and college physics bear upon the same general field, the treatment is so different that what is gained from a study of one does not help greatly in a study of another."

The validity of this reasoning in the case of Hurd's study may be questioned. He obtained data from analyses of college and high-school texts in physics. The facts disclosed were that the quantitative, mathematical concepts were emphasized in college and the objective qualitative aspects in the high school. It seems unwarranted to say that a good descriptive course in physics does not contribute something, perhaps much, to an understanding of the quantita-

[4] Noll, Victor H. *Laboratory Instruction in the Field of Inorganic Chemistry.* Minneapolis. Minnesota: University of Minnesota Press. 1930.

[5] Powers, S. R. "A Comparison of the Achievement of High School and University Students in Certain Tasks in Chemistry." *Journal of Educational Research* 6: 332–343; November, 1922.

[6] Koos, L. W. *The Junior College.* Minneapolis, Minnesota: University of Minnesota Press. 1924.

[7] Hurd, Archer W. "High School Physics Makes Small Contribution to College Physics." *School and Society* 31: 468–470; April 5, 1930.

tive aspects stressed in the college course. Certainly some achievement comparisons need to be presented before we can arrive at any sound judgment about the matter.

The point I wish to make is that high-school chemistry and high-school physics are not set up so as to form a sequence with college courses and that at the present time this leads to dissatisfaction among college teachers with their students' preparation and the lack of definite aim on the part of the high-school teacher. If high-school science courses are to be preparatory and prerequisite to college courses this aim will make a very great difference with both content and method. The fact now is that science subjects given in high school and offered for college entrance are not satisfactorily related to the first college courses.

The last complaint which I may submit is the fact that many, perhaps most, of the students who offer science as one of their entrance subjects do not propose to specialize in science in college. Stated in another way, we may say that some students who take high-school physics will take physics in a technical school, some in a college of liberal arts and some will go to college and never take another course in physics. The same may be said of chemistry and of biology. We have in our high-school-science classes students of many different vocational and cultural interests. This has a bearing on the "what" and the "how" of their science courses in the high school. Shall we give the same course in chemistry or physics or biology to students who are going to different kinds of higher institutions or for different purposes? There is evidence that survey courses meet the desires and supply the needs of college students who are taking liberal arts courses.

Finally it ought to be mentioned that there is a definite dissatisfaction with the failure of colleges to accept science on complete equality with languages to meet entrance requirements. The New York State Science Teachers Association passed a resolution in two successive years stating its belief that "The requirements for a College Entrance Diploma and for free state scholarships should be so revised as to put a student specializing in sciences on a par with a student specializing in languages." The recognition of sciences for college entrance is slowly coming. The complete acceptance of them as adequate preparation for college depends, to some extent, upon our maintaining high standards of work. But it seems fair, at the same time, to say, that if the college teachers of science know what kind of training in science is desirable for successful college work, they have failed to pass on the information to the secondary schools.

We have now surveyed briefly some of the perplexities which are involved in answering the question, what is the relation of high-school science to college science. Now just as briefly let us review some proposed solutions. By "proposed solutions" I refer to practises which are now found in some schools as well as to proposals which have not been tried.

First, is the proposal to give two courses in high school for each specialized science. One of these will be practical, presumably for the student who will not go to college and the other will be adapted to college entrance requirements. Such a practise is rather common in New York City. In my own department I have a course in Applied Chemistry and in General Chemistry. The former is designed for pupils not going to college.

Another proposal is that all science courses in high schools be designed for all pupils whether they will go to college or not. This is the practise in most schools. This, however, requires a decision as to whether or not such courses shall accept the college entrance board definition of biology or physics or chemistry. Professor Bancroft, the same person who recently received the publicity for his report of the rejuvenating properties of sodium rhodo-

nate, is also the sponsor for what he terms "Pandemic Chemistry," meaning chemistry for all the people.

This proposal is closely related to another: that the syllabi of the high-school-science courses be rewritten to make them equally valuable for college and non-college students. This proposal comes from those who emphasize the habits and attitudes of the scientist. The claim of this group of educators is that if all school work is pupil-centered, the candidates for college will receive development at the rate at which they can proceed. Others who do not propose to go to college likewise may be developed to their best advantage. According to this point of view, science courses should not stress subject matter but use subject matter to train in scientific methods. This proposal has not been tried seriously as far as I know. Moreover, it would require a change of heart on the part of the colleges. That is to say, either the college would have to accept the certificates of school for such courses, or an entirely new means of college entrance examination would have to be devised.

The College Entrance Board examinations have been studied from time to time by investigators. Gerry[8] in 1920 and Boorstein[9] in 1931 made such studies of chemistry. Their studies indicate that the content of the examinations is largely informational and that no noteworthy changes or trends are observable.

On the other hand, the adoption in some colleges of comprehensive entrance examinations such as those in use in Columbia College indicates the possibility of a change toward acceptance of "power" rather than mere information. In a monograph, *Measurements in High Education,* Ben D. Wood, director of admissions to Columbia College, says that the elements upon which college success depends are:

1. A certain minimum of native intelligence, not below the twentieth percentile of human intelligence. In Columbia the range accepted for entrance is between the tenth and fifteenth percentile.
2. A certain minimum of preparation. "The tendency has been to decrease the number of subject matters prerequisite to college and to emphasize power."
3. Character and Moral Habits "The most prominent of these is "hard work."
4. Health.
5. Interest.
6. Adjustment of academic load to capacity and aptitude of students.
7. Avoidance or overcoming of worry and distractions.

Still another proposal is to break down the barriers of our high-school-science subjects and to give General Science for four years under the name Science 1, 2, 3, 4. I do not know that this is actually being tried, but in 1920 in the High School of Commerce in New York City an attempt was made to do this. In that instance the plan collapsed because of the inability of the chairmen of the various subjects to agree on what percentage of any given year's course should be biology, chemistry or physics.

A proposal of the American Chemical Society is that high schools should prescribe courses in the sciences (in this case Chemistry) which develop the elementary principles of each science subject much as is done now, with minimum and enriched requirements. If a very comprehensive examination involving mathematical and theoretical problems was used we presumably could distribute the students in some rank according to their ability. From this distribution those above some arbitrary rank correlated with ability to do college work could be accredited for college. Those of the lower ranks could be "passed" but not accredited for college.

It appears then that the question of what sort of high-school-science courses

[8] Gerry, Henry L." College Entrance Examination Board Questions in Chemistry." *School Science and Mathematics* 20: 845–888; December, 1920.

[9] Boorstein, J. W. "An Analysis of the College Entrance Examination Board Examinations in Elementary Chemistry for 1921 to 1928." *Science Education* 15: 91–100; January, 1931.

are suitable foundations for college science is a part of a much larger picture—that it cannot be decided apart from other questions which are intimately tied up with it. We need to decide what are the aims of education, what kind of college science is to be prepared for, and what sort of individuals are to be trained. When we have done this, we have then to select, order and administer the activities or experiences which will result in the desired outcomes. High-school-science subjects are contributory to the education of boys and girls. College-science subjects continue this training. What kind of products do we desire or expect to turn out? The question of articulation should consider how the students may develop progressively. Courses either in high school or college are not ends but means.

What sort of students should go to college and what constitutes "success"? Even on this simple query there is no unanimity of judgment. For the college point of view, two principles will probably be accepted as guiding. These are admirably stated by Ben Wood whom I quoted earlier. He says: "Native intellect is the *sine qua non* which sets limits within which other factors have significance for college work." This is the first principle then, only students with capacity for profiting by college should go and hence they are the ones for whom our college preparatory science courses should be adapted. Secondly, Wood sets the limits of this group within the upper twenty percentile of human intelligence. This means that if only the upper mental levels of the population are to be prepared for college, the courses should offer a challenge to active effort of the high grade student.

It follows that if we accept these principles that any tendencies to make college preparation in science easier or more descriptive, or more "practical" or less quantitative, or less mathematical should be discouraged. These proposals are based on the wrong assumptions. The understanding of chemistry, physics or modern biology requires intelligence asserted to be possessed only by the upper 20 percentile of the population. This demands ability to think in terms of mathematical concepts and in abstract ideas. Students who possess these abilities should be given intellectual meat and not soup. They should be stimulated to work and not allowed to dawdle or mark time on easy tasks which were adjusted to lower levels of ability.

We cannot, at the present time, direct our high-school courses in science toward particular college courses. On the other hand, the function of the college is presumably to introduce students to what President Butler calls "The Great Tradition." This means acquaintance with, and some understanding of, accumulated human experience—the cultural and liberal arts and sciences. It means, further, that the prospective student should possess the capacity to assist later in adding to this understanding of the world. Learning and research, these are the activities of a college. Science is one of the chief fields of activity. To prepare for study of more science, we can begin to train in those habits which we know will be required. These need not be enumerated here. We know what they are. They come under the general heading of scientific methods and scientific attitudes. John Dewey is perhaps the greatest proponent of this viewpoint. If the College Entrance Board would define courses for preparation which stress the development of scientific thinking ability and could devise tests to determine the possession of this ability in different degrees, we might give the same courses to all students who take science. Until such a general plan is adopted, we need steadfastly to resist efforts to lower the bars so that the least able can jump over them.

In summary, the proposed remedies for the difficulties cannot all be adopted, and makeshift compromises do not cure. We need to find means of distinguishing potential scholars from students who for lack of ability or lack of desire will not follow academic pursuits. Public schools are provided for all, not for the college aspirant only. We must provide, in the secondary school, activities which challenge the interest and effort at full capacity of those who will go to college and for those who will not. There are four questions which stand out among the proposals for adapting science courses to these needs:

1. Shall we have minimum courses such as the one in chemistry proposed by the American Chemical Society and provide for the more able by enrichment and supplementary activities?
2. Shall we have different courses for the college-preparatory students and the non-college students?
3. Shall we offer "pandemic" science to all secondary school students alike, and select for college those able to give evidence in a comprehensive test of ability to do college work?
4. Can the colleges tell the secondary school some of the qualities which they would like students to have and which might be developed by courses in secondary school science?

As to the content of the courses for those going to college, we seem to be able to agree only that they should not be made easier. Students capable of doing college work should be faced with real difficulties in high-school science. Personally, I am in favor of retaining in chemistry the ionic hypothesis, equation writing, mathematical problems and of including the electron theories and even of introducing whatever of wave mechanics or the quantum theory may be understood without higher mathematics. In physics, I would retain the mathematical calculations and quantitative relations. These are necessary to any understanding of physics as a science and they offer the challenge to effort necessary to develop the desired mental habits. On the other hand, we cannot ignore the needs of the large number of students who for lack of ability or of desire will not go to college. Those who are unable to comprehend such matters as we have just mentioned will not profit by their study; and those who will not use this technical knowledge in future study might more profitably investigate some of the environmental problems of science which undoubtedly would enrich their everyday lives.

In conclusion, it appears that the question "What science for college entrance" is not simple. It involves decisions of what to do with other students who are not going to college; what sort of work is to be done in college; what sort of individuals we are expecting to be produced by the process of education; what subject matter to include or leave out; whether information or training in habits are to be emphasized—and many other perplexities. My thesis—if indeed any can be discerned from this discussion—is that the question of articulation of high-school and college science requires scientific study by a national committee representing the colleges, secondary schools and technical men in industry. We need to study the whole puzzle before we will know how to put in the pieces. I believe the "Program for Teaching Science" as proposed by the National Society for the Study of Education in the Thirty-first Yearbook, Part I, is the nearest approach to a correct attack. If the National Education Association could continue this study with special attention to articulation of the secondary-school and college sciences their work would have the proper authority and scope for general acceptance. The Association of Science Teachers of the Middle States might very properly make such recommendations. Our immediate contribution may be to recognize the nature of our difficulties and to urge some attack on the problem by authoritative national organizations.

ORIENTATION IN CHEMISTRY

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Courses in "Science Orientation," "Survey of Science," or "Introduction to Science" are now being presented in an increasing number of colleges, both liberal arts and teachers colleges. Such courses generally include instruction in chemistry, physics, botany, zoology, and astronomy; and less frequently in physiology, geology, and bacteriology.

This discussion shall concern itself with that part of these courses dealing with chemistry. This part will be considered under the general head of *Orientation in Chemistry*. Reference will also be made to courses in chemistry separate from courses in general science which may lead directly or indirectly to what is commonly called orientation. In this connection will be mentioned courses in the history of chemistry and those which have to do with the applications of chemistry.

That college courses in science of a general nature do fill a definite need and have a desirable function can hardly be questioned. In order to retain or increase these advantages, it is my opinion, based upon some experience with the work, that the chemistry unit of an orientation course should have certain definite objectives and that the course should be presented in a manner that will easily fulfill these objectives.

For the first objective we have to aid the student in the selection of his major field, by giving him a more intelligent basis of selection. Evidence from questionnaires filled out by two hundred freshmen of our college recently indicated that a course in science orientation, of which chemistry was an important part, influenced approximately forty per cent of the students who decided on a science major. While this figure should not be taken as generally representative of the influence of science orientation courses on the student's selection of his field of concentration, it is sufficient to indicate a tendency. In this connection, however, no attempt should be made to solicit chemistry majors in the orientation course. In fact, the students may be frankly informed about the technical difficulties of higher branches of chemistry.

A second objective of the course in chemistry orientation is to familiarize all students with the role of chemistry in daily life. In carrying out this objective, the applications and accomplishments of chemistry are to be clearly presented. This objective is particularly important to the large number of students who do not intend to continue the study of chemistry and who need to be broadened and enlightened concerning the power and deeds of chemistry. It is difficult to get a student to realize that the chemistry of the classroom is the same as that which he meets in daily life. Common salt seems one thing to him when it is on the laboratory shelf, labeled NaCl, and quite another in the shaker on the dinner table. Many students after completing an entire year of work in the subject are still unable to cite a single application of the science or to understand even such common terms as *alcohol, carbohydrate,* or *sterling silver*. For the complete realization of this objective, numerous specific applications of chemistry should be given the student. In an orientation course, I believe, it is preferable to present, as much as possible, the *applications* of a science, apart from theories and technical terms.

A third objective is to acquaint the student with the historical development of chemistry. This objective can be effectively carried out by a brief study of the lives, and a deeper study of the contributions, of the most outstanding workers in the field of chemistry. If this study is made chronologically without undue emphasis, on dates, the student becomes acquainted

with the progressive march of chemistry, as well as the most notable achievements in the science.

The objectives of a course should determine its content. In this connection we recognize two large divisions, or units. One has to do with the specific applications and relationship of chemistry to daily life, to industry, to medicine and pharmacy, to agriculture, to warfare, and to other sciences. The other has to do with the historical development of chemistry as illustrated by a study of the lives of some of its most important contributors. In connection with the historical part, also, some cursory attention should be given to the theoretical complexities and lecture experiments should be performed to illustrate and clarify the discoveries and contributions of the principal workers.

Teaching orientation in chemistry causes one to feel that such a course should be incorporated into the curricula of most colleges and particularly into the chemistry curriculum. It seems to be reflection on our system of chemical education that one may complete an entire major in this field without having even heard about the work of Theodore Richards, of Irving Langmuir, or of other Nobel Prize winners in the field of chemistry. From this standpoint, the orientation course, in my opinion, should be given near the beginning of the college career of the prospective major in this science. It may thus serve as a kind of bridge for the gap between high-school and college chemistry.

The orientation course advocated in this discussion, broadening, enlightening, adjusting, and inspiring the student at the beginning of his college work, would hardly be necessary for those who take a major in chemistry if the course in general college chemistry were made more practical, more human and biographical. But this is exactly what we, for the most part, do not do. We assume that all of the time should be given to the theory itself and none to the author of the theory. We assume that the student will not have to be told about the applications of chemistry if he masters the theories of chemistry. He will, we say, make and see the applications himself. We may be justified in this conclusion in the case of the brilliant student or the one who can be expected to go more deeply into the study of the science; however, we must remember that our main concern in the course advocated here is, first, with the many students who will not take any more chemistry at all, second, with the smaller number who will take only one year of chemistry, and last, and least of all, with those few who intend to major in the science, although they, too, can get much of value out of it.

It is the duty of the chemistry teacher to educate the individual, the layman, in the broad and varied field of chemical achievment, and orientation courses are most effective in this respect. It is true that courses in the history of chemistry or in the applications of chemistry fulfill a part of the function of an orientation course, but many colleges do not offer either of these courses.

We have already noted the danger of too much emphasis on laws and theories, in a course of this type. It is very easy for a teacher to become so deeply involved in the explanation of a law or hypothesis—let us say Avogadro's hypothesis—that the hour passes away in theoretical discussion and the student loses sight of Avogadro himself. We may reasonably doubt that it is more important for the average college student to know, for example, the relationship between Avogadro's hypothesis and Gay-Lussac's law of combining volumes, than it is for him to know that Avogadro had a hypothesis and that this principle is the fundamental basis of the daily useful determination of molecular weights.

I have already been asked about the amount of time which should be given to the chemistry unit of the orientation course. A number of teachers of courses of this type find themselves crowded for time. In the course which we have been giving for the

past two years we have found that it requires at least twenty-four clock hours to present the chemistry unit adequately. This corresponds to one and one-third semester hours, and means that the entire course in science orientation may be worked into a course of from four to five semester hours. Shorter units in other sciences make feasible the teaching of more sciences or the shortening of the entire course. In the twenty-four clock hours which we have set aside, approximately twelve are consumed in the study of the lives and contributions of the makers of chemistry and twelve in the applications of the science to other fields. When we consider the vast amount of reference literature now appearing in these two large divisions, it is not at all difficult and seems to me to be important that twelve clock hours be devoted to each division. When we further consider the fact that analysis has disclosed that only twelve per cent of the content of the average high-school text in chemistry is practical and industrial in nature, we seem justified in the deduction that no more than that proportion of the average college text-book in chemistry is of this sort of material; then we can see a real need for a course of this kind.

The method of presenting the course is by lecture-demonstration. It is a simple matter in connection with the biographical descriptions of Becher, Priestley, Cavendish, Lavoisier, Arrhenius, and others, to give demonstrations of their experimental contributions to chemistry. These experiments seem to clarify and fasten the achievements of these personalities in the minds of the student. It has also been found in connection with the method of the course, that slides may profitably be used to illustrate some of the industrial applications of chemistry.

A term paper on one of the builders of the science of chemistry or on one phase of the application of the science is a valuable method of giving the student an opportunity to exhaust and test his own potentialities in this most diversified, yet fundamental course.

ELEMENTARY SCHOOL SCIENCE REFERENCE AND INSTRUCTIONAL MATERIALS*

G. V. Bruce
New Jersey State Teachers College, Newark

BIBLIOGRAPHY NO. 1. SCIENCE REFERENCE MATERIALS FOR CHILDREN

2. GENERAL NATURE SERIES AND READERS—(*Continued*)

Sharp, Dallas Lore. *The Year Out-of-Doors.* Houghton Mifflin Company, 2 Park Street, Boston, Mass.

It contains chapters on Things to See, Things to Do, and Things to Hear, The Fall of the Year, Winter, The Spring of the Year and Summer. Grade 8. $0.52.

Sharp, Dallas Lore. *Ways of the Woods.* Houghton Mifflin Company, 2 Park Street, Boston, Mass.

The following are some of the chapters: An Account with Nature, Along the Highway of the Fox, Chickadee, Hunting the Snow, Leafing, The Missing Tooth, The Muskrats are Building, The Palace in the Pig-Pen, Turtle Eggs for Agassiz, Woods Medicine. Grade 8. $0.56.

Shirling, Albert E. *Outdoor Adventures.* World Book Co., Yonkers-on-Hudson, N. Y.

A nature study reader written around the experiences of two boys. It provides study helps to stimulate individual inquiry and to furnish projects for class group work. Grades 3–5. $1.00.

Thomas, Roy H. *Living Things Around Us.* J. B. Lippincott Co., 1249 S. Wabash Ave., Chicago, Ill.

A nature study reader for the middle grades, designed especially to meet the needs of rural schools. It draws widely on agriculture for its material. New type tests and other modern study helps are included. 38 illustrations. Grades 4–6. $0.76.

* (Continued from April, 1935, issue).

TORELLE, ELLEN. *Plant and Animal Children.* D. C. Heath & Co., 231 West 39th Street, New York. 1912.

This book presents the essential facts in the life history of plants and animals. In connection with each type discussed is given an account of the manner in which its reproduction is accomplished. Illustrated. Grades 6–7. $0.96.

TRAFTON, GILBERT H. *Nature Study and Science.* The Macmillan Co., 60 Fifth Ave., New York.

This book is arranged on the basis of seasonal events. It makes use of plants, weeds, trees, flowers, common animals and birds, rocks and minerals, the weather and the stars as subject matter. Grades 4–6. $1.20.

WARNER, CHARLES DUDLEY. *In the Wilderness.* Houghton Mifflin Company, 2 Park Street, Boston, Mass.

A Hunting of the Deer, Camping Out, A Character Study, A Fight with a Trout, How I Killed a Bear, How Spring Came in New England, Lost in the Woods, What Some People Call Pleasure. A Wilderness Romance. Grade 8. $0.48.

WARREN, MINETTA L. *From September to June with Nature.* D. C. Heath & Co., 231 West 39th Street, New York. 1898.

This book contains lessons upon both plant and animal life. The work is divided into months, each group being especially appropriate to a particular month. Illustrated. Grades 2–3. $0.84.

WEED, CLARENCE M. *Farm Friends and Farm Foes.* D. C. Heath & Co., 231 West 39th Street, New York. 1910.

In this text the author leads the pupil to a first-hand knowledge of the friends and foes among the common weeds, insects, fungi, birds and mammals found in the vicinity of the school. In agricultural districts, especially, this would be a very serviceable reading for upper grades. Illustrated. Grades 7–8. $1.68.

3. THE WORLD'S WORK AND MATERIALS

BROOKS, EUGENE C. *The Story of Corn.* Rand McNally & Co., 536 S. Clark Street, Chicago, Ill. 1917.

A story of the vital rôle played in the building of the great American nation by one of the world's greatest agricultural food products. It is an industrial romance which cannot help but appeal to the boy and the girl. It contains many half tones and maps. $1.00.

BROOKS, EUGENE C. *The Story of Cotton.* Rand McNally & Co., 536 S. Clark St., Chicago, Ill. 1911.

Beginning far back in the remote days of antiquity, this story presents the gradual development of one of the world's greatest industries, and its influence on the development of the Cotton States. Halftones and maps add further interest to the content. $0.80.

COOKE, A. O. *The World at Work.* Oxford University Press, 114 Fifth Ave., New York. 1930.

This is a story of six of the world's industries. They give a knowledge of the process by which materials are transformed and the extent to which industry controls our daily lives. Illustrated with color plates, photographs, plans and diagrams. Grades 6–8. Each $0.45.

(1) A Visit to a Coal Mine; (2) A Day in an Iron Works; (3) A Day in a Ship Yard; (4) A Day with Leather Workers; (5) A Visit to a Woolen Mill; (6) A Visit to a Cotton Mill.

CRANDELL, HELEN H. *Little White Cotton.* Frederick A. Stokes Co., 443 4th Ave., New York.

The adventures of a little boy whose interest in cotton is awakened one night by the cotton elf on his pillow. During the days that follow he discovers for himself how it grows and how its fluffy white balls are picked, ginned and packed, manufactured and used. Illustrated. Grades 2–3. $1.00.

CRISSEY, FORREST. *The Story of Foods.* Rand McNally & Co., 536 S. Clark St., Chicago, Ill. 1917.

All about the romantic journey of food from producer to consumer. A genuine wonder book. Lavishly illustrated with photographs. $1.20.

FAIRBANK, HAROLD W. *Consevation Reader.* World Book Co., Park Hill, Yonkers-on-Hudson, N. Y. 1932.

This book would be helpful in giving young people a basis for understanding the importance of conserving natural resources. Grades 5 and upward. $1.20.

GREENE, HOMER. *Coal and the Coal Mines.* Houghton Mifflin Company, 2 Park St., Boston, Mass.

"Coal and the Coal Mines" tells the complete story of coal—the mystery, beauty, and romance of its beginnings, and its history with relation to civilization. The chapters on the mines and the conditions under which miners work give an excellent account of this basic industry. Illustrated. Grades 7–9. $1.24.

GRUENING, MARTHA. *The Story of Mining.* Harper & Brothers, 49 East 33rd St., New York.

Here, for younger readers, is told, in graphic form, the story of the development of mining, from its more or less accidental beginnings to scientific mining today. A thrilling tale, full of adventure, of tragedy, of interest. Illustrated. Grades 7–9. $1.00.

Hall, Jennie. *Weavers and Other Workers.* Rand McNally & Co., 536 S. Clark St., Chicago, Ill. 1917.

The shepherd and his flock are presented in song and story, with rather more emphasis upon the industrial than the poetic phase of his calling. The processes of spinning, weaving, dyeing are also explained to the pupil in a series of simple narrative lessons. $0.64.

Namburg, Elsa H., Lambert, Clara, Mitchell, Lucy S. *Sky Scraper.* The John Day Co., 386 Fourth Ave., New York. 1934.

The story of the building of sky scrapers told in prose and verse for the interest of young readers. It describes the process from start to finish. Illustrated by seventy exciting photographs. $2.00.

Peattie, Donald Culross. *Cargoes and Harvests.* D. Appleton and Co., 35 West 32nd St., New York.

Illustrated with interesting decorative maps. A colorful narrative of the historical facts of the discovery and exploitation of rubber, tobacco, opium, quinine, cotton, coffee, the potato, and many other plant products. Plants, which, with the increasing population, may some day serve as food are discussed in the final chapter. Grades 7–9. $2.50.

Peterham, Maud and Miska. *The Petersham Series.* John C. Winston Co., 1006 Arch St., Philadelphia, Pa. 1934.

This series of books is written for the purpose of acquainting very young children with the story of how we provide the four most essential human needs. They are attractively illustrated. Grades 1–3. Each $0.45.

(1) The Story Book of Clothes; (2) The Story Book of Houses; (3) The Story Book of Food; (4) The Story Book of Transportation.

Rush, Chas. E., and Winslow, Amy. *The Science of Things About Us.* Little, Brown and Company, 34 Beacon St., Boston, Mass. 1926.

In order to satisfy the often fruitless curiosity of children to know how things are made and from what they come, the authors, both experienced librarians, tell the story of ninety-four common things: matches, ink, tin cans, rope, etc. Grades 6–7. $0.90.

Scarborough, Dorothy. *The Story of Cotton.* Harper & Brothers, 49 E. 33rd St., New York.

This book tells about the history and development of cotton—its effect on the industrial revolution, and its place in industry today. Entertainingly told, with delightful drawings by Harold Sichel. Grades 7–9. $1.25.

Shilling, Elnora E. *The Four Wonders.* Rand McNally & Co., 536 S. Clark St., Chicago, Ill. 1913.

A fascinating description of the four textiles—cotton, wool, linen, silk. All the processes in the development of these materials to their end in warp and woof are told with simplicity and charm. Drawings and water colors by Charles Copeland. $0.72.

Watson, Elizabeth. *The Story of Bread.* Harper & Brothers, 49 East 33rd St., New York.

The industrial revolution told in terms of bread—from home baking to modern bakeries. Illustrated. Grades 5–6. $0.90.

Watson, Elizabeth. *The Story of Milk.* Harper & Brothers, 49 East 33rd St., New York.

This traces the history of the production and use of milk from the days of the herdsman to modern dairy farming. Illustrated. Grades 5–6. $0.90.

Worthington, J., and Mathews, C. V. *Our Materials Series.* The Owens Publishing Company, Danville, N. Y.

This series of four books explains the sources and preparations of the essential materials of daily use in illustrated form. Grades 3–5.

Our Food, 1930, $0.72; Our Clothing, 1931, $0.72; Our Shelter, 1934, $0.80; Our Transportation, 1934, $0.80.

Watson, Elizabeth. *The Story of Textiles.* Harper & Brothers, 49 East 33rd St., New York.

Another phase of the industrial revolution seen through textiles written for the interest and enlightenment of children. Illustrated. Grades 5–6. $0.90.

4. THINGS TO MAKE

Allen, E. L. *Model Airplanes: How to Build and Fly Them.* Frederick A. Stokes Co., 443 4th Ave., New York.

This book, recommended by the Boy Scouts of America, tells how to make model airplanes for racing and how to make replicas of many famous planes, among them the Curtiss "Jennies," the Fokker tri-motor, and Lindbergh's "Spirit of St. Louis." The opening chapters explain the necessary first principles of airplane construction and flight, and throughout the text the diagrams are abundant and clear. $3.50.

Bofter, Leon H. *Electrocraft in Theory and Practice.* Bruce Publishing Co., 129 E. Michigan St., Milwaukee. 1925.

This book is full of suggestions for construction and practice in electricity. It gives clear directions and diagrams for making bells, buzzers, telephones, cells, and instructions for simple wiring. Grades 4–9. $1.50.

BAILEY, CAROLYN SHERWIN. *Boy's Make-at-Home Things. Girls Make-at-Home Things.* Frederick A. Stokes Co., 443 4th Ave., New York.

Popular books which contain practical directions for making many useful articles and toys out of spools, cardboads, and other easily found material. Fully illustrated. Grades 3–6. $2.00.

BEARD, PATTEN. *The Complete Playcraft Book.* Frederick A. Stokes Co., 443 4th Ave., New York.

The title is scarcely an overstatement of the contents, for here is a compilation of the best ideas from Miss Beard's three earlier books, together with eight new chapters full of useful things and games to make from boxes, spools, nuts, fruits and paper. There are illustrations from photographs and many diagrams. Grades 1–6. $2.50.

COLLINS, FREDERICK A. *The Boys' Airplane Book.* Frederick A. Stokes Co., 443 4th Ave., New York.

The facts every boy wants to know about the airplane, its history, construction and uses. The book tells the story of the airplane's development and gives a description of its principles and of the most important types of aircraft, with full directions for making models that will really fly. With 150 illustrations, working drawings and diagrams. $2.00.

COLLINS, A. FREDERICK. *Boys' Book of Submarines.* Frederick A. Stokes Co., 443 4th Ave., New York.

A brief history of the submarine, directions on how to make and work a model submarine together with much information on the real boats, how they are operated, living on them, types of engines, the construction and shooting of the torpedo. There is also an interesting chapter on the submarine chaser. Many illustrations and working drawings. $1.50.

COLLINS, A. FREDERICK. *Handcraft for Boys.* Frederick A. Stokes Co., 443 4th Ave., New York.

Complete explanations and descriptions of articles of all sorts for boys to make. The subjects include scroll sawing, wood carving, metal working, glass work, toy making, the rudiments of mechanical drawing, how to make photographs and blue prints, etc. With over 200 working diagrams. Grades 6–9. $1.50.

DERATTI, AUREL. *The Model Engineer Series.* Distributed by Spon & Chamberlain, 123 Liberty St., New York. 1925.

No. 8—Simple Electrical Working Models. How to Make and Use Them. Fully illustrated. $0.25.

No. 9—Simple Mechanical Working Models. How to Make and Use Them. Fully illustrated. $0.25.

No. 10—Small Dynamos and Motors. How to Make and Use Them. Illustrated. $0.25.

No. 11—Small Electric Motors. How to Make and Use Them. (48 illustrations). $0.25.

DIXON, RACHEL T., HARTWELL, MARJORIE. *The Funcraft Book.* Rand McNally & Co., 536 S. Clark St., Chicago, Ill. 1929.

This book shows how plain paper and boxes can be changed into things of interest and beauty. It gives directions for making animal toys, paper lanterns, decorations and other novelties. Grades 3–4. $0.40.

HALL, A. NEELY. *Big Book of Boys' Hobbies.* Lothrop, Lee & Shepard Co., 275 Congress St., Boston, Mass. 1929.

The book is in four divisions, one for each season of the year. It includes suggestions for organizing a hobby club as well as individual hobbies. Chapters are devoted to model airplanes and ship models. Grades 6–9. $2.50.

HALL, A. NEELY. *Home-Made Toys for Girls and Boys.* Lothrop, Lee & Shepard Co., 275 Congress St., Boston, Mass. 1915.

This describes a large variety of toys that can be made out of materials that can be picked up around the home. It contains over 300 illustrations and working drawings. Grades 5–9. $2.00.

HALL, A. NEELY. *Making Things with Tools.* Rand, McNally & Co., 536 S. Clark St., Chicago, Ill. 1928.

This gives all sorts of projects on making boats, airplanes, motors, kites, whistles, gifts and other creative work. With the aid of the simple instructions these things can be made from the scraps of materials that can be found about the home. Grades 4–5. $0.40.

HAMILTON, EDWIN T. *Complete Model Aircraft Manual.* Harcourt, Brace & Co., 383 Madison Ave., New York. 1933.

This 600 page book written by an aviator is an encyclopedia of model aircraft building. Sixty-five different models are included, among them the "Winnie Mae," autogiros, flying blimps and new types of airplanes. There are 250 full pages of illustrations of construction details. A complete aviation dictionary is included. Ages 10 up. $3.50.

HAMILTON, EDWIN T. *Handicraft for Girls.* Harcourt, Brace & Co., 383 Madison Ave., New York. 1933.

All the most popular kinds of handicraft clearly explained—stenciling and crayon printing, paper mosaic, hooked rugs, art metal work, paper pottery, block printing, garden modeling, masks, fancy costumes, prizes, favors and six others. A practical and useful book of a type always in demand. Ages 12 up. $3.00.

HAMILTON, EDWIN T. *Prizes and Presents Every Girl can Make.* Harcourt, Brace & Co., 383 Madison Ave., New York. 1934.

This gives plans and directions for articles that girls as young as eight can make. Many of the

things can be made from materials found about the home. Illustrated. Grades 3–6. $2.50.

Hamilton, Edwin T. *The Boy Builder.* Harcourt, Brace & Co., 383 Madison Ave., New York. 1933.

This is a treasure book for the boy who likes to make things. It gives full directions for making more than 100 articles out of wood. After explaining tools and the use of them, a chapter is devoted to what a boy may like to build in the spring—for example a tennis practice board, a batting practice range, and kite construction. For the summer there is a tree house, an outdoor shower, a model submarine, etc. Other chapters deal with things to make at camp, in the winter, and for gifts. Ages 10 up. $2.00.

Henley's. *20th Century Formula Book.* The Norman W. Henley Publishing Co., 2 West 45th St., New York. 1934.

This is considered the most complete collection of formulas, processes and recipes on the market for home, shop and laboratory. It contains directions for more than 10,000 processes, how to make adhesives, alloys, anti-freezing solutions, cements, fillers and practical tested methods for doing things. Grades 6 up. $4.00.

Klenke, W. W. *Unique Simple Toys.* McKnight & McKnight, 109–111 W. Market St., Bloomington, Ill. 1935.

This is a choice group of twelve unique toys that can be made from inexpensive materials. Each toy has a definite play value when completed. Outlines for construction are clear and photographs of the finished toys are shown. Grades 1–4. $0.50.

Kunou, Charles A. *Easy-to-Make Toys.* The Bruce Publishing Co., 524 N. Milwaukee St., Milwaukee, Wis. 1934.

The book consists of 67 projects that are new, original, and of real educational value. It contains a list of essential tools and materials, and directions for designing, cutting out, and finishing the toys. Grades 6–9. $1.44.

Leitch, Albert C. *Miniature Boat Building.* The Norman W. Henley Publishing Co., 2 West 45th St., New York. 1928.

This gives the specific design and construction of the models of eleven famous racing, sail and power boats. Illustrated with scale drawings and 500 progressive pictures. The process is complete from the selection of material to the completed and polished boat ready to operate. Grades 6 up. $3.00.

McCann, Captain E. Armitage. *How to Make a Clipper Ship.* The Norman W. Henley Publishing Co., 2 West 45th St., New York. 1934.

In this book the author tells how any one with a few tools can make a model of the American Clipper Ship, "Sovereign of the Seas." The entire building and rigging are given to scale from start to finish. Grades 6 up. $2.50.

McCann, Captain E. Armitage. *How to Make a Model of U. S. Frigate Constitution.* The Norman W. Henley Publishing Co., 2 West 45th St., New York. 1928.

Many sources have been searched for information so as to make this book as authentic as possible for the amateur. It contains complete instructions. The first part is a simplified plan and the second part gives all details. Grades 6 up. $2.50.

McCann Captain E. Armitage. *How to Make Worth-While Models.* The Norman W. Henley Publishing Co., 2 West 45th St., New York. 1927.

This gives the design and detailed plans for building two famous Spanish models. They are decorative and colorful. The method has been so simplified that they can be made by any one who is handy. Grades 6 up. $2.50.

McIsaac, F. J. *The Tony Sarg Marionette Book.* The Viking Press, 18 East 48th St., New York. 1921.

This gives the whole story of how to make marionettes, stage settings and operation. It also includes plays for home-made puppets. Illustrated by Tony Sarg. $1.00.

Morgan, Alfred P. *Boys' Home Book of Science and Construction.* Lothrop, Lee and Shepard Co., 126 Newbury St., Boston, Mass. 1921.

This book sets forth the way a boy's interest in science may be satisfied at home. It contains chapters on chemistry, mechanics, liquids, sound, heat, light, electricity and meteorology. There are illustrations and many drawings. Grades 6–9. $2.50.

Morgan, Alfred Powell. *The Boy Electrician.* Lothrop, Lee & Shepard, 126 Newberry St., Boston, Mass. 1929.

This book is filled with suggestions for the construction of electrical toys, apparatus, and appliances such as the push-button, buzzer, telegraph sets, electric cells, and motors. The directions are complete and diagrams clear. Grades 5–9. $2.50.

Plimpton, Edna. *Your Work Shop.* The Macmillan Co., 60 5th Ave., New York. 1926.

This book suggests many things to make and do with tools that are simple enough for small children. Some of the chapters are, The Workshop, Tools, The Paint Question, The Wood Pile, Some Wooden Toys, Puppet Shows, Jack of All Trades, Boats that Sail, etc. Grades 4–6. $1.50.

Polkinghorne, R. K., and M. I. R. *Toy Making in School and Home.* Frederick A. Stokes Co., 443–449 Fourth Ave., New York.

This is an essentially practical book teaching how to make, with very few tools, original toys out of paper, cork, match-boxes, reels and odd pieces of wood and cardboard. It is sectioned by grades. Illustrated. Grades 1–9. $4.00.

POPULAR MECHANICS PRESS. *Make it Yourself.* Popular Mechanics Press, 200 E. Ontario St., Chicago, Ill.

This book contains directions for 900 articles the amateur mechanic will enjoy making. It includes mechanical toys, models, a vast number of articles of art from leather, wood and metal and many useful things for all purposes. Grades 5–9. $3.00.

POPULAR MECHANICS PRESS. *The Boy Mechanic.* Popular Mechanics Press, 200 E. Ontario St., Chicago, Ill.

Book I. 1919; Book II. 1915; Book III. 1919; Book IV. 1925. $2.00 each. Hundreds of articles for boys and girls to make.

ROMER-ROMER, RALPH AND MARGARET. *Sky Travel.* Rand McNally & Co., 536 S. Clark St., Chicago, Ill. 1929.

Through the adventures of a boy and girl in an aviation center, "Sky Travel" tells the story of the conquest of the air down to to-day. Great flyers and inventors and the "who's who" of the upper air, give a personal interest to the narrative. In the appendix are suggestions for activity work for grades and high schools. The work is illustrated with half tones, and with diagrams for airplane parts. $1.20.

SCIENTIFIC AMERICAN. *Amateur Telescope Making.* Precision Optical Supply Co., 991 E. 163 St., Bronx, N. Y.

It gives complete directions and sources of materials for making practical telescopes. This is one of the most favored books by the amateur. $3.00.

SHAFER, D. C. *Everyday Electricity.* Harper & Bros., 49 East 33rd St., New York.

This shows how to make and use everyday appliances for the home, shop and laboratory. Grades 8–12. $1.50.

SLOANE, THOMAS O'CONNER. *Electrical Toy Making.* Norman W. Henley Publishing Co., 2 W. 45th St., New York City. 1923.

This book contains a wide range of novel toys and devices that can be made by children from inexpensive materials. Secret signal devices, electric insects that flap their wings, alarm for the ice-box, and electric door locking devices typifying the interest this book can have for children. Grades 4–9. $3.50.

SHOWALTER, HAZEL F. *The Box Book.* The Macmillan Co., 60 Fifth Ave., New York.

This book suggests many amusing, interesting and valuable things to make in school or at home. Clear diagrams and patterns are given for things that include, Buster box, Jumping Jack, scales, automobiles, wheelbarrow, ferris wheel and many others. Grades 2–6. $1.75.

U. S. P. BOOK CO. *How to Make Things Electrical.* U. S. P. Book Co., 250 Fourth Ave., New York City.

This is another good book of simple construction and practice in electricity for children. Numerous activities such as: toy cannons, rain alarms, telephones, heaters, and so forth are clearly explained and illustrated. Grades 4–9. $1.50.

WILLIAMS, ARCHIBALD. *Things Worth Making.* Thomas Nelson & Sons, 381 Fourth Ave., New York. 1920.

This contains a great number of articles that can be made at home as: Things for the Study, Things for the Kitchen, Things for the Garden, Windmills and Model Steam Turbines. It is profusely illustrated. Grades 6–9. $1.72.

WOODHULL, E. A. *Home Made Apparatus.* A. S. Barnes Co., 67 W. 55th Str., New York City.

This book contains numerous suggestions for the constructing of apparatus for demonstrating a wide range of phenomena and processes such as convection, conduction, distillation, thermometry, and so forth. Inexpensive materials are used throughout the book. Grades 4–9. $1.50.

WRIGHT, H. B. *Toys Every Child Can Make.* The Bruce Publishing Co., 524 N. Milwaukee St., Milwaukee, Wis. 1930.

The books contains many original, humorous and delightful drawings of patterns intended for toy making in elementary woodworking classes. It contains complete directions for the finishing of each article. Grades 3–6. $1.60.

Editorials and educational news

THE TRAINING OF SCIENCE TEACHERS

A study of present state requirements for teaching certificates reveals that diversity of practice is perhaps even greater than had been supposed. For example in the case of two adjoining New England states, the college graduate in one is required to have but two semester hours in education for a license to teach whereas across the line he must have at least twelve! At the end of two years he must have eight semester hours in the first state, while in the second he must have twenty-four before he can obtain a professional certificate good for five years. With respect to practice teaching, the contrast between these states is even greater. The first state requires nothing in the way of practice teaching while the second requires one semester of full-time apprenticeship under a critic approved by the state department before a professional teaching certificate is issued. Moreover, no amount of experience in teaching before application for a certificate is made in this state is accepted in lieu of the requirement in practice teaching. It is rather disturbing to find two states with needs for teachers undoubtedly very similar in such disagreement as to how those needs may best be provided for.

The three main elements in the prospective teacher's program are professional courses, practice teaching, and academic specialization. Variations exist in all three, from situations in which practically nothing is specified, and little or nothing required, to some in which requirements seem to go too far in the opposite direction. With such great variations in requirements for a teaching license the problem of training teachers for our secondary schools is not an easy one. It is no less difficult for those concerned with the training of teachers of science than for those in other fields.

The sad part of the whole matter is the effect on the instruction and the pupils in our secondary schools. In the end it is the pupil who suffers. He is taught biology by a teacher who never studied it, or chemistry by one who hasn't seen a high-school classroom or laboratory since his own high-school days, or general science by one who holds concepts of education akin to those of the schoolmasters of the Middle Ages. It is indeed a reflection upon modern education and modern educators that such inadequately trained persons and persons with such widely varying types of training are permitted to teach. There is a great need for careful studies of the qualities that make for success in science teaching, as well as in other fields, and the building of teacher training programs that will make substantial and measurable contributions to the development of such qualities. There is also need for discussion and cooperative appraisals of requirements for certification in the various states so that a common basis for progress can be reached. Common sense, coupled with a scientific study of the problem, will go far towards the attainment of a more satisfactory situation for all concerned.

VICTOR H. NOLL,
Rhode Island State College

PRINCIPLES VERSUS FACTS

Whether we are willing to admit it or not, the fact remains that the objective

which dominates the teaching of science in most of our secondary schools today is the imparting of mere factual information. This objective is a heritage from the past when courses were more strictly technical because they were frankly designed to prepare a more highly selected group for college. The emphasis upon learning and retaining factual information, however, deserves the criticism that it encourages the memoriter type of course with all its attendant evils. It encourages and rewards chiefly the pupil who possesses a facile memory. Success in the course is often measured by the pupil's immediate recall of the facts he has learned by assiduous cramming and has retained for the examination period only.

The fact-learning goal merits the further criticism that it encourages much uninspired and even incompetent teaching. Commonly the teacher assigns for the following day "the next five pages," or the "next list of problems," and devotes the subsequent class period to oral quizzing to ascertain the extent to which the pupils have "mastered" the facts included in the lesson assigned. Furthermore, teachers with inadequate and occasionally with no training in science, whatever, undertake to teach science courses, relying upon their intelligence and maturity to enable them to "keep ahead of the class." Once they have taught the course a few times and have by repetition mastered its factual content, they can thereafter teach it with maximum confidence and minimum effort.

But thoughtful teachers of science have always worried because their pupils have proved perversely and almost universally unable to retain for more than a brief period the facts they were supposed to have learned. A number of careful investigations have shown conclusively that the goal of mere fact learning is a futile one because the pupils never really achieve it. Conscientious teachers therefore ask in discouragement, "What shall we try to teach?" An answer is, "Shift your emphasis from teaching facts for their own sake to teaching facts as a means of giving the pupils an understanding of principles. Make the facts serve not as an end in themselves but as the means to a more important as well as a more practical end."

There has been much loose thinking and writing about principles; probably nobody would be willing to state dogmatically what a principle is. A practical working definition, serviceable in most situations, however, is that a principle is a generalization derived from facts. The greater the array of facts which the statement generalizes, the more nearly the statement as a principle approaches the dignity of a "major generalization."

The learning of such facts as contribute to a comprehension of a scientific principle is important. But once the principle has become established in the pupil's mind, it is a matter of small consequence whether or for how long he retains an accurate knowledge of the facts which served to bring to him a clear understanding of the principle. For example, the fact that a certain moth is invisible against the bark of a tree is likely to be of importance only in helping the pupil to comprehend the principle of protective coloration. The fact that the sun is ninety-three million miles from the earth has served its only significant purpose for the pupil when it has helped him to gain a conception of the principle (or major generalization) "space is vast."

Emphasis upon the teaching of scientific principles, with its accompanying emancipation from fact-learning for the mere sake of fact-learning, raises at once the whole plane of science teaching and learning. Only the well-trained teacher who knows his field through an extensive study of it is qualified to teach principles. Only such a teacher is able to focus his attention "upon the forest rather than upon the individual trees." Furthermore, the pupil who has had his attention consistently directed beyond the minutia of detail to the broad generalizations which the detailed facts estab-

lish is likely to complete the course with a mind well stored with scientific understandings with their as-yet-undetermined-but-nevertheless - admitted potentialities for functioning in out-of-school and in later life situations.

Francis D. Curtis,
University of Michigan

AMERICAN SCIENCE TEACHERS ASSOCIATION

The Council of the American Association for the Advancement of Science authorized its Committee on the Place of Science in Education to prepare a program which was given at Pittsburgh on December 29, 1934. At this meeting there was organized The American Science Teachers Association open to all teachers of science and to delegates of other science associations. The Organization Committee of the new association, under the chairmanship of Harry A. Carpenter, Specialist in Science, Rochester Public Schools, has prepared the following program to be held on January 2, 1936, in Parlor A, Statler Hotel, St. Louis, Missouri, during the meetings of the American Association for the Advancement of Science:

Morning Program—9 A. M. to 11:30 A. M.
Ellsworth S. Obourn, John Burroughs School, Clayton, Missouri. *Presiding.*

Missouri Botanical Gardens as an Educational Institution for the Public. (Illustrated).
Dr. George T. Moore, Director of the Missouri Botanical Gardens, St. Louis, Missouri.

Advances in Medical Science and Surgery with Special Reference to Diseases of the Glands of Internal Secretions. (Illustrated).
Dr. Russell M. Wilder, Professor and Chief of the Department of Medicine, Mayo Foundation for Medical Education and Research, University of Minnesota, Rochester, Minnesota.

Radio Tomorrow—The New Magic of Electrons.
Dr. Orestes H. Caldwell, Editor of *Radio Today*, New York City.
The radio knife, the electric eye, the electric tongue, the location of underground treasure, the ship's eye that sees through fog, the talking book, electricity from the heart, and many other wonders of modern science, will be discussed and illustrated.

Dr. Caldwell will also outline some of the many ways in which the new art of electron control, developed from radio technique, is revolutionizing science, industry, technology, chemistry, surgery, therapeutics, metallurgy, mining, music, entertainment, and printing, as well as influencing practically every activity of human life.

Luncheon—12 o'clock noon.
Dr. Otis W. Caldwell, Chairman of the A. A. A. S. Committee on the Place of Science in Education and General Secretary of the A. A. A. S. *Presiding.*

Address.
Dr. Karl T. Compton, President of the A. A. A. S.

Afternoon Program—2 P. M.
Harry A. Carpenter, Specialist in Science, Rochester Schools, Rochester, New York. *Presiding.*

Ten Years of Science Books.
Dr. Hanor A. Webb, Head of Chemistry and General Science Departments, George Peabody College for Teachers, Nashville, Tennessee.

Pupils' Ability to Generalize.
Dr. W. C. Croxton, State Teachers College, St. Cloud, Minnesota.

Evaluating Various Aspects of the Scientific Method.
Dr. Ralph W. Tyler, Professor of Education, Ohio State University, Columbus, Ohio.

A Plan of Organization for the American Science Teachers' Association.
Dr. Phillip G. Johnson, Graduate School of Education, Cornell University, Ithaca, New York.

Election of Officers.

Exhibition of Pupil Work in Science.
Opportunity will be provided for visitors to view this exhibit before and after the luncheon, and at the close of the afternoon meeting.

SAINT LOUIS LOCAL ARRANGEMENTS COMMITTEE

Ellsworth S. Obourn, John Burrough's School, *Chairman.*
W. R. Teeters, Supervisor of Science, St. Louis Public Schools.
W. F. Shay, Head of Science Department, Normandy High School, Normandy, Missouri.
King Barnett, Science Department, Webster Groves High School, Webster Groves, Missouri.
J. P. Davis, Science Department, Clayton High School, Clayton, Missouri.
M. P. Schultz, Chemistry Department, University City High School, University City, Missouri.
Ralph K. Watkins, Department of Education, University of Missouri, Columbia, Missouri.

S. C. Griffle, Department of Education, Washington University, St. Louis, Missouri.
Rudolph Bennett, Department of Zoology, University of Missouri, Columbia Missouri.

Reservations for the luncheon are in charge of W. R. Teeters, Supervisor of Science, Board of Education Building, Ninth and Locust Streets, St. Louis, Missouri.

NEW YORK STATE SCIENCE ASSOCIATION

The thirty-ninth annual meeting of the New York State Science Teachers' Association will be held at Syracuse, New York, on December 26 and 27. The annual meeting of the Board of Directors is scheduled for 2:00 p. m. on Thursday, December 26. On Friday, December 27, the general meetings will consider the theme, "Science Through Student Activities" in line with the following program:

9:40 A. M.—*Motion Pictures.*
An educational science film of recent release.

10:00 A. M.—*Pupil Activity in the State Science Program.*
Dr. Warren W. Knox, State Supervisor of Science.

10:45 A. M.—*Pupil Adventures in Science.*
Dr. Morris Meister, Chairman of the New York City Student Science Fair and the Student Science Clubs; also editor of the *Science Classroom.*

12:15 P. M.—*Luncheon.*
Board of Directors, Hotel Syracuse, Syracuse Central High School, Room 307.

1:45 P. M.—*New Discoveries in the Growth and Development of Plants.*
Dr. P. W. Zimmerman, Plant Physiologist; Boyce Thompson Institute for Plant Research.

2:45 P. M.—*Specific Applications of Science Through Student Activity in High School Subjects.*
General Science: E. L. Osborne, Hudson Falls.
Biology: Mary Nelson, Boonville.
Physics: Francis Almstead, Clinton.
Chemistry: William B. Sanford, Painted Post.

4:00 P. M.—Business Meeting; Report of Directors.

ELEMENTARY SCIENCE—C. A. S. M. T.

The Elementary Science Section of The Central Association of Science and Mathematics Teachers presented the following program at its meeting held on Friday, November 29, 1935, at the Palmer House, Chicago, Illinois:

A Point of View in Science Teaching.
Dr. Otis W. Caldwell, Teachers College, Columbia University, New York City.

Science in the Elementary Science Program.
Glen Blough, Supervisor of Elementary Science, Michigan State Normal College, Ypsilanti, Michigan.

The Radio and Elementary Science.
Mary Melrose, Supervisor of Elementary Science, Cleveland Public Schools, Cleveland, Ohio.

Visual Materials in the Teaching of Science in Elementary Schools.
(Illustrated).

General Discussion.
Led by Bertha Parker, The University of Chicago, Chicago, Illinois.

Florence G. Billig, Chairman, Wayne University, Detroit, Michigan.
Lillian Hethershaw, Vice-Chairman, Drake University, Des Moines, Iowa.
Geraldine Shontz, Secretary, State Teachers College, Terre Haute, Indiana.

NEW JERSEY SCIENCE TEACHERS' ASSOCIATION

The Second of the eight association meetings for the year was held at the Atlantic City Convention Hall, Room 2, on Saturday, November 9, 1935. The following program was presented:

R. B. Whitmayer, *Presiding.*

A Proposed Program for General Science Teaching in New Jersey.
Merwin M. Peake, Lafayette Jr. High School, Elizabeth, N. J.

A Teacher's History of the Microscope (Illustrated).
J. I. Wexlin, Bausch and Lomb Optical Company, Philadelphia, Penna.

Business Meeting.

Silicate Solutions, Their Importance to Industry.
James G. Vail, Vice President of the Philadelphia Quartz Company, Philadelphia, Penna.

Light and Life.
Ivor Griffith, Philadelphia College of Pharmacy and Science, Philadelphia, Penna.

ELEMENTARY SCIENCE EXHIBIT

The exhibits and program of the fourth conference of the Elementary Science section of the Iowa State Teachers' Association was held at Drake University, Des Moines, Iowa, November 1, 1935. The Elementary Science exhibit held in the General Science rooms at Drake University was viewed by approximately 1,000 of the 9,000 teachers who attended the State Teachers' Association meetings.

Miss Lillian Heathershaw, head of the General Science Department at Drake University, was chairman of the exhibits and program. About 400 persons attended the program of the Elementary Science section held in the Auditorium at Drake University.

The program consisted of the following:

Demonstration Lesson in Science, *Rocks and Minerals in Everyday Life.*

The pupils were from the 4th grade of the Lincoln School, Valley Junction, Iowa, and the teacher was Miss Illa Podendorf, Supervisor of Elementary Science, Newton, Iowa.

Rocks and Minerals.

Dr. H. S. Conard, Grinnell College, Grinnell, Iowa.

An exhibit of pupil activities in Science from the kindergarten through grade six from school systems in Iowa was on display in the General Science rooms. The Science units were representative of work from the kindergarten and each of the six grades of the Elementary schools. More school systems sent in units of Science than ever before.

Books for pupils and teachers were on display on tables and lists of these books for distribution for the visitors.

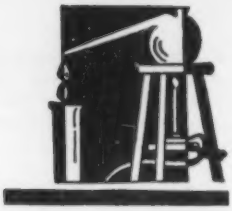
THE NATIONAL COUNCIL OF GEOGRAPHY TEACHERS

The twenty-second annual meeting of the National Council of Geography Teachers will be held in the Hotel Chase, St. Louis, Missouri, Friday and Saturday, December 27–28. There will be five sessions and a dinner. For Sunday, December 29, a field trip around St. Louis is scheduled. Arrangements for reduced railroad fares have been made. A national broadcast over the Columbia Broadcasting network will occur.

Speakers and discussion leaders from various sections of the country will consider (1) The Content of Geography for Beginners, (2) Geography in the Senior High School, (3) Advertising Geography, (4) Professionalized Subject Matter in Geography, (5) Geography in World Relationships.

Requests for programs and further information concerning the annual meeting may be addressed to Erna Grassmuck, Chairman, Educational Relations Committee, State Teachers College, Indiana, Pennsylvania.

Abstracts



SCIENCE IN THE SECONDARY SCHOOL

CUNNINGHAM, WILLIAM A. "Sulfur," I. *Journal of Chemical Education* 12: 17–23; January, 1935.

This is a most interesting article on the two chief methods of producing sulfur, namely, the Sicilian method and the process invented by Herman Frasch. The biographical data introduced concerning Frasch should help to arouse genuine interest in this ingenious process. —V.H.N.

CUNNINGHAM, WILLIAM A. "Sulfur," II. *Journal of Chemical Education* 12: 83–87; February, 1935.

In this part of the article on sulfur, the author describes the engineering phases of the Frasch process as used today. This portion of the article is just as interesting, in a somewhat different way, as the first installment. —V.H.N.

GARARD, IRA D. "The Organization of Ideas in General Chemistry." *Journal of Chemical Education* 11: 650–653; December, 1934.

A plea for reorganization of the subject matter of courses in general chemistry into larger and fewer, but more coherent and logical units. The present-day textbooks show little fundamental change during the past thirty years. The content is divided into from thirty to fifty chapters with little sense or logic to such divisions. The modern course, should, in addition to being reorganized as stated, provide for differentiation between students who have had high-chool chemistry and those who have not; it should have a historical introduction; it should give training in scientific method, and it should treat theories and hypotheses as explanations of facts, not as facts themselves. The author gives twelve topics about which a course in general chemistry may be organized. —V.H.N.

Symposium: "Values and Shortcomings of Subject-fusion Projects." *California Journal of Secondary Education* 10: 269–302; April, 1935.

The April issue of *The California Journal of Secondary Education* is chiefly devoted to a symposium on subject-fusion which includes the following articles; "Integration: Potentially the Most Significant Forward Step in the History of American Secondary Education," by William A. Smith; "To Fuse or Not to Fuse," by Melanie C. Ainsworth; "The Fusion of Subject-Matter," by Alexander C. Roberts; "Values and Shortcomings of Subject-Fusion Projects," by C. H. Woodruff; "Some Hazards in Subject-Fusion Projects," by Aylmer J. Hamilton; "Integration in the Classroom," by Byron M. Taylor; "What Takes Place in the Integrated-Type Classes," by Walker Brown and Ray Compton; "A Bibliography of Material Relating to Unified Types of Learning," by Walker Brown and Ray Compton; and "Criteria for Testing the Soundness of Subject-Fusion Projects," by Percy R. Davis. —F.D.C.

PRESTON, C. E. "The Science Column." *The High School Journal* 18: 63–65, 67; February, 1935.

The State of North Carolina has adopted one text in each of the high-school sciences. Mr. Preston's discussion of this clearly points out the dangers and inconsistencies which may result from such a method or textbook selection. The text in one science may be based on an entirely different educational philosophy than the text in another. In the following several issues of the *Journal* Mr. Preston's column discusses the adopted texts and how to adapt them to varying conditions of local need and varying class backgrounds. —O. E. Underhill.

DUNBAR, RALPH E. and BETTS, HELEN JO. "The Problem Content of Twelve High-School Chemistry Textbooks." *Journal Chemical Education* 12: 187–189; April, 1935.

Analysis of twelve high-school chemistry textbooks showed the median number of problems to be 90 with a range of 33 to 181. Most of the problems deal with reacting weights, weight and density calculations, composition, and gas volumes. Proportion, division and multiplication are required almost exclusively, and in the order named with respect to frequency of use. —V.H.N.

HELLWEG, J. F. "Paradox Eclipse Will End the Day Before It Begins." *Science News Letter* 25:71; 75; February 3, 1934.

This article describes an unusual result following from natural causes. It is the coming (now past) total solar eclipse on February 13–14, 1934, which will go down in history as the paradox eclipse, the eclipse that ended the day before it began! —C.M.P.

HUNT, HERSCHEL. "Demonstrations as a Substitute for Laboratory Practice in General Chemistry." *Journal of Chemical Education* 12: 73–75; February, 1935.

A discussion of the values of a two-hour demonstration period as compared with a three-

hour laboratory period in the first course in college. Granting that no one has proved the clear superiority of either method of conducting laboratory work, the demonstration method can be shown to save time and expense. —V.H.N.

Anonymous: "Film Production Activities." *Educational Screen* 14: 198; September, 1935.

This department announces four new sound pictures in the field of geology produced with the cooperation of the University of Chicago and the National Park Service, and released by Erpi Picture Consultants. The films are as follows: *Ground Water, Geological Work of Ice, Volcanoes in Action* and *Mountain Building.* If these are up to the standard of the other recent Erpi releases they should prove valuable additions to the film library of those institutions equipped for sound movie projection. Among other releases reviewed in this department are *Milk, the Master Builder,* and *Preventing the Spread of Disease,* silent films, available for purchase on either 16 mm. or 35 mm. stock, produced by National Motion Pictures and photographed by Floyd Crosby.

—O. E. Underhill.

Symposium: "Characteristics of a Sound Guidance Program in a Functional Secondary School." *California Journal of Secondary Education* 10: 357–390; May, 1935.

The May issue of the *California Journal of Secondary Education* is chiefly devoted to a symposium on guidance which includes the following articles: "Why Have Guidance?" by George C. Jensen; "When Shall We Have a Sound Guidance Program in the Secondary Schools?" by Harold C. Hand and Verna A. Carley; "A Guidance Program for Secondary Schools," by Virgil E. Dickson; "The Place of Mental Hygiene in the Guidance Program," by Virginia Lee Block; "The Length of the Assignment as a Factor in Mental Health," by Virginia Lee Block; "Guidance and the Curriculum," by Mardele Robinson; "Counciling in the Secondary Schools," by Herman A. Spindt and Leo B. Hart; "The Mental Hygiene Emphasis in Guidance," by Albert D. Graves; and "A Vocational Guidance Technique," by J. O. McLaughlin.

—F.D.C.

Bradbury, G. M. "What Shall We Teach in Chemistry?" *School Science and Mathematics* 35: 368–373; April, 1935.

The author quotes the list of fourteen objectives of high-school science proposed by the Wisconsin State Science Committee, then states the following principles which he thinks should govern the selection of subject matter for the course in high-school chemistry: (1) "The material to be learned should be interesting;" (2) "The material should be valuable (the criterion of value is 'what chemical principles are in use by the average person');" (3) "The pupils should know as definitely as possible what they are expected to learn;" (4) "They should receive expert aid in learning how to go about to learn;" (5) "They should be given plenty of opportunity to put what they have learned into thinking and explaining and acting;" (6) "The pupils should be helped to see that complete chemical principles are not learned as a whole, but gradually unfolded as progress is made in experience and training to think chemically." —F.D.C.

Crowley, C. A. "Designing and Building Electromagnets." *Popular Mechanics* 64: 470–476; September, 1935.

This is a most excellent article and should prove extremely useful in any science laboratory. Graphs and tables are given showing various constants for types of iron and steel, size of wire, number of turns, and so on, so that a magnet of given characteristics can be designed without the use of complicated mathematics. Designs are given for magnetically operated devices such as a magnetic door latch and directions for calculating windings so as to gain the most efficiency taking into consideration both pull and length of "stroke." Simple electromagnets are very inefficient for long strokes. This is the first treatment of this subject the reviewer has seen, which answers many of the questions which have arisen in his classes in connection with the designing of magnets and yet is not too technical but what high-school students may easily comprehend it.

—O. E. Underhill.

Broome, Frank H. "A Combination Unit." *Educational Screen* 14: 198, 205; September, 1935.

An arrangement is described whereby microprojection and the projection of slides or opaque material may be conveniently carried on and in such manner that shifts from one type of material to the other may easily be made. By this arrangement microprojection may be presented on the upper portion of the screen simultaneously with the showing of opaque material on the lower portion, thus making it possible to compare microscope preparations with photographs or drawings of the same materials.

—O. E. Underhill.

Beck, Paul V. "The Organization of High-School Biology on a Seasonal Basis." *School Science and Mathematics* 35: 717–721; October, 1935.

The author states as his underlying thesis, "The course must be based on biological principles." The topics which he advocates for study are these and in the order here given: "(1) Insects are both friends and enemies of man's food supply; (2) The living plant makes and stores the food of the world; (3) Our food problem is also a health problem; (4) Some small organisms also affect our health; (5) Plants and

animals have very interesting methods of reproduction; (6) Biological principles are important in the human race." —F.D.C.

CROWLEY, C. A. "How to Make Solenoids." *Popular Mechanics* 64: 632–637; October, 1935.

The author of the article telling how to design magnets, reviewed elsewhere, has followed it by an equally valuable description of solenoid designing. Descriptions are given for designing both A. C. and D. C. solenoids and utilizing them in such devices as model railroad signals and gaming devices which shoot steel balls. Detailed instructions are given for figuring ampere turns, size of wire, etc., and the necessary wire tables are given to enable this to be done easily.
—O. E. Underhill.

WHEELER, RAYMOND HOLDER. "Gestalt Psychology in Relation to Education." *California Journal of Secondary Education* 10: 445–449; October, 1935.

As the title suggests, this article gives in succinct form essential information about Gestalt Psychology. The author enumerates the postulates upon which Gestalt Psychology is based and the educational philosophy implicit in the Gestalt theory. He enumerates points of contrast between the older psychology and the Gestalt Psychology in the teaching of tool subjects. He ends his article with a detailed statement of "what Gestalt Psychology is not."
—F.D.C.

ROEMMERT, GEORG. "The Microvivarium." *The Educational Screen* 14: 94–96; April, 1935.

Dr. Roemmert describes briefly the projection of microscopic life in a "microvivarium" as developed by him first in Berlin, later in this country, for use in schoolrooms, and culminating in his exhibit at the Century of Progress Fair. It is suggested that such exhibits might be maintained in cities and become "the biological analogue of the Planetarium."
—O. E. Underhill.

HANNA, PAUL R. "A Proposal for a Social Studies Curriculum for the Secondary Schools." *California Journal of Secondary Education* 10: 421–428; October, 1935.

This able article is part of a symposium on the social studies which occupies the major portion of this issue of the *California Journal of Education*. The author summarizes his article thus:

1. "The objectives of the social studies instruction are to develop an understanding of human relations and the attitudes and skills essential for improving social life."

2. "The content of the social studies involves the facts and concepts incident to man's struggle to satisfy certain major social functions, and draws this content from the various social science disciplines."

3. "The key concepts deal with (1) man's present advanced control over nature, inhibited by social ideals and institutions carried over from a more primitive cultural pattern; and the concept of (2) the revolutionary character of the means (institutional arrangements) by which man, in varying environmental situations, carries out the major social functions."

4. "The method implies the use of environmental situations faced by the pupils for the purposes of studying to determine how the situation may be improved." —F.D.C.

MACHARG, JOHN B. "The Miniature Camera Way of Visual Instruction." *Educational Screen* 14: 123–125; May, 1935.

The convenience and advantage in using a camera which carries a 35 mm. motion picture film for preparing your own strip film for projection is set forth with some suggestions as to how to get good results.
—O. E. Underhill.

Aonymous. "Be Your Own Weather Man." *Popular Mechanics* 64: 227–228, 411–413; August and September, 1935.

A brief discussion of reading weather maps and taking observations with simple instruments.
—O. E. Underhill.

Anonymous. "Practical Experiments with Ammonia." *Popular Mechanics* 64: 614–617; October, 1935.

Experiments described include the action of ammonia on metal oxides which make it valuable as a cleaner and polish; emulsion formation of oil and oleic acid used as polishes, insecticides and other properties where the properties of both oil and water are desired in the same substance; freezing water by rapid evaporation of ammonia to illustrate its use as a refrigerant; and illustrations of the extreme solubility of ammonia. —O. E. Underhill.

Anonymous. "Sure Sounds Like Bill." *Popular Mechanics* 64: 600–605; October, 1935.

Describes the construction of a toy telephone, with carbon button, induction coil, and bell circuit, making a workable two-way circuit.
—O. E. Underhill.

SCIENCE

LILLINGSTON, CLAUDE. "Our Parasites: The Flea." *Hygeia* 12: 1091–1093; December, 1934.

In this article, the seventh of the series, the author discusses the life habits of various kinds of fleas that live upon man, rats, and other mammals. He indicates the importance of fleas in conveying diseases, such as plague, trypanosomiasis, kala azar, and certain diseases associated with anemia. Besides carrying bacilli, the

flea is also the intermediate host of the larval stage of the tapeworm common in dogs. The author suggests various methods of eliminating fleas. Special emphasis is given to the method of fighting the flea that carries bubonic plague. This is essentially a campaign against the rat and ground squirrel that are often infested with the plague bacillus. —F.G.B.

Lillingston, Claude. "Our Parasites: The Clothes Moth." *Hygeia* 13: 141–143; February, 1935.

Entomologists are interested in distinguishing between the different species of clothes and house moths. The housewife, however, is concerned primarily with the larval stage which is the destructive stage of all of the species. It is in this stage that the moth destroys woolens, hair, feathers, and museum specimens. In time of need, the larva has been known to become a vegetable feeder attacking stored grains and sugars. It has been found feeding upon ginger, linseed, and saffron and at times on poisons, such as aconite rot and Indian hemp.

The author discusses various common ways of combating moths. Teachers will be especially interested in the treatment suggested for preserving stuffed birds and mounted insects from the ravages of moths. —F.G.B.

Lillingston, Claude. "Our Parasites: The House Fly." *Hygeia* 13: 242–245; March, 1935.

The author presents the life habits of the common house fly that make it a menace to health. He points out the various methods that have been used successfully in exterminating flies, such as destroying breeding places, using commercial fly poisons, and using a maggot trap, like that described in Farmers' Bulletin No. 1408 published by the United States Department of Agriculture. Natural enemies take a heavy toll —a parasitic fungus kills large numbers of them in late summer and early fall; bacterial diseases are common; some insects, such as wasps and ants, live on the adult fly; spiders are enemies of flies; and certain ants use eggs, larvae, and pupae as food. —F.G.B.

Myers, J. Arthur. "Why Condition the Air?" *Hygeia* 13: 22–25, 42, 87–89; January, 1935.

The modern home and public building of to-day is one in which air is conditioned by removing from it foreign materials, such as pollen and dust, by warming or cooling it to the desired temperature, and by increasing or decreasing the amount of moisture to give the proper humidity. The author explains that the delay in refinement of air conditioning is due largely to three factors: (1) the mysteries and superstitions relating to air and health, (2) the fact that for a long time only the chemistry of air was given much attention, and (3) the effect of the educational program of the fresh air faddists.

The experimental work of Evans and Hill in 1914, of the New York Ventilation Commission in 1923, and of various students, definitely proved that qualities of air, such as temperature, humidity, and circulation, are directly responsible for discomforts, headaches, loss of appetite, and, in extreme cases, even death. The author gives many illustrations in which air conditioning is an important factor in treatment of various types of illness. F.G.B.

Lillingston, Claude. "Our Parasites: Harvest-Mites and Ticks." *Hygeia* 13: 322–325; April, 1935.

The families of the harvest-mite and tick contain many species and are wide-spread over the world. They are of importance because of characteristics that are troublesome to man and some groups of others animals. The author describes the life habits of each of these families, points out their dangerous characteristics, and suggests treatment commonly used in eliminating them. —F.G.B.

Lillingston, Claude. "Our Parasites: The Mosquito." *Hygeia* 13: 414–417; May, 1935.

It is probable that all mosquitoes are nuisances but only a few are dangerous. The dangerous ones carry diseases, such as malaria, yellow fever, and dengue fever. "The diseases for which the mosquito is responsible are mainly tropical and it has been estimated that one-fourth or more of all sickness in the tropics can be traced to this source." The author discusses their life history, their natural enemies, how they live over the winter, how they are distributed, their dangers to man, various ways of eliminating them, and the treatment to give their bites. —F.G.B.

Michael, W. H. "The Black Widow." *Hygeia* 13: 530–531; June, 1935.

The black widow spider is one of the most poisonous of all spiders found in the United States. The description given this dangerous spider will make it possible for any observing person to identify it. He discusses the symptoms resulting from its bite and suggests treatment of an afflicted person. He emphasizes war against the black widow as the best solution of the problem it has created. —F.G.B.

Hyler, John E. "The Production of Salt." *Journal Chemical Education* 12: 203–207; May, 1935.

The first part of this article gives some historical data regarding early use and methods of obtaining salt. Modern methods have improved greatly both the yield and quality of this important product. Much of our present-day supply of salt comes from underground deposits but large quantities are also produced by the evaporation of natural brines. —V.H.N.

ANONYMOUS. "The Millionth Part of an Inch." *Popular Mechanics* 62: 831–832; December, 1934.

Mass production methods are dependent upon precision measurement. Carl Johansson, "the most accurate man in the world," in association with Henry Ford, has produced the gauge-block system of high-precision measurements by which accuracy to within two one-millionth parts of an inch can be obtained. The faces of these gauges are so exact that cohesion between two of them will support 200 pounds.

—O. E. UNDERHILL.

CUNNINGHAM, WILLIAM A. "Sulfur," III. *Journal of Chemical Education* 12: 120–124; March, 1935.

The third article in this series describes the various forms in which sulfur exists and their properties. The uses of sulfur are described including some that are not generally known. The article closes with a statement regarding the available and potential supply of sulfur.

—V.H.N.

FENTON, CARROLL LANE. "The Mountains of Glacier Park." *Natural History* 35: 213–220; March, 1935.

The mountains of Glacier Park are one of the youngest sections of the Rocky Mountains, being barely 60,000,000 years old. However, some of the rocks found here are very old—probably 600,000,000 years old. This illustrated article traces the steps by which these mountains developed. —C.M.P.

COATES, C. W. "Submarine Power Plants." *Natural History* 35: 209–212; March, 1935.

This article describes fish that generate electricity with which to shock their enemies and overcome their prey. The exact manner in which the electricity is generated is a debatable question. Especial attenion is paid to the catfish and the electrical eel. —C.M.P.

LEONARD, DONALD D. "The Story of Silk." *Natural History* 35: 221–236; March, 1935.

This illustrated article is one of the best the abstractor has ever read relating to the history, culture, manufacture and economic importance of silk. —C.M.P.

DICKERMAN, WILLIAM C. "There's Life in the Old Iron Horse." *Scientific American* 152: 180–181; 222; April, 1935.

This article by the president of the American Locomotive Company advances the thesis that steam locomotives will continue to have an important place in our railroad transportation systems. Electric trains have important advantages, but certain disadvantages are likely to prevent the immediate electrification of all railroads. The speed records made by the Zephyr and M-10001 must be viewed as special test performances under special conditions and not ordinarily practicable to day-by-day railroad operation. It is true, however, that we are likely to witness great improvement in the design, speed and comfort of passenger trains, and also in the speed of freight trains. —C.M.P.

FOWLER, FREDERICK HALL. "Week-Ends with the Prairie Falcon." *The National Geographic Magazine* 67: 611–626; May, 1935.

This is a very interesting article on the nest life and flying habits of the elusive prairie falcon. There are 21 illustrations. —C.M.P.

SHAPIRO, H. L. "Mystery Island of the Pacific." *Natural History* 35: 365–377; May, 1935.

This is an account of the Crocker Pacific Expedition to that extraordinary island, Easter Island, and its strange civilization. It has an equal interest both for science and the general reared because it is one of the most isolated spots on the globe, it contains a large number of huge monolithic statues and it once had a series of wooden tablets with, as yet, an undeciphered script. Illustrated. —C.M.P.

HACKH, INGO W. D. "Development of Chemical Symbols." *The Scientific Monthly* 40: 199–217; March, 1935.

This excellent article traces the development of symbolism in chemistry from the ideogrammatic hieroglyphs of the Egyptians and the allegorical symbolism of the alchemists to the electronic structure symbolism of today. Illustrated. —C.M.P.

HAMBLETON, JAMES I. "Man's Winged Ally, the Busy Honeybee." *The National Geographic Magazine* 67: 401–428; April, 1935.

This is one of the best articles extant on the life and work of the honeybee. There are 18 illustrations, and 16 paintings from life by Hashime Muragama. —C.M.P.

ALLEN, ARTHUR A. "The Tanagers and the Finches." *The National Geographic Magazine* 67: 505–532; April, 1935.

This is the eleventh article in a series describing the bird families of the United States and Canada. There are 55 portraits in color from life by Major Allan Brooks. —C.M.P.

MCCORMACK, GEORGE RANDALL. "Amazing Tests Create New Race of Giant Bees." *Popular Science Monthly* 126: 14–15, 107; June, 1935.

The greatest apiary laboratory in the world is located near Vincennes, Indiana, where Jay Smith has developed bees that won't sting, bees that produce more honey, and bees that build larger combs. Bees from this apiary have been distributed all over the world. Smith has developed a new race of giant bees that contain an average of 200 fewer bees per pound than the famous Caucasians, long known as the giants of the bee family. Larger bees can carry more nectar and go longer distances to get it. Ordi-

nary bees work up to distances of eight and a half miles, but cannot obtain nectar from red clover. Smith hopes to develop a race of bees that cannot only work a greater distance than this, but also can work in red clover. —C.M.P.

Montgomery, Jr., Frank A. "An Oriental Plant in the Occident." *Scientific American* 152: 310–311; June, 1935.

On a forty-six acre farm near Savannah, Georgia the government is carrying on an investigation with 275 species of the bamboo to supply a two-million dollar demand. Long the most useful of all oriental plants, its versatility and possibilities are attracting American agriculturalists. It is now being used in this country for making paper, tooth brush handles, flag poles, radio aerials, furniture, ladders and food. —C.M.P.

Brown, Barnard. "Sinclair Dinosaur Expedition, 1934." *Natural History* 36: 3–15; June, 1935.

This illustrated article describes the excavating of the great Jurassic dinosaur quarry of northern Wyoming. About 4000 bones were excavated, the remains of parts, at least, of twenty dinosaurs who lived 140,000,000 years ago when this region was becoming arid. Just prior to that time the climate was tropical, and the land was flat with numerous shallow lakes and marshes and rich in vegetation. Cycads, palms and palmettos covered the lowlands, and pines the highlands. Then the climate became arid, the vegetation and water disappeared and the dinosaurs lost out in the struggle for existence. —C.M.P.

Simonds, J. P. "The Nature of Cancer." *Scientific Monthly* 40: 535–540; June, 1935.

This excellent article on the history and causes of cancer states the following conclusions: (1) cancer is not an infectious disease, is not transmissible, and carries no stigma of which the patient need be ashamed; (2) cancer cells are derived from the cells of the patient's own body. They undergo some deep-seated change that renders them fundamentally unlike any other cells of the body in any stage of its development; and (3) the most important agencies or influences that induce cancer are heredity and chronic irritation. Most cancers appear to be the result of the combined action of these two factors. —C.M.P.

Urey, Harold. "Heavy Water." *Scientific American* 152: 300–302; June, 1935.

In this article, Professor Urey reviews the important rôles that deuterium or heavy hydrogen may play in the sciences of chemistry, physics and biology. He points out how the new hydrogen and the new water both have physical and chemical properties distinctly different from those of hydrogen and ordinary water.—C.M.P.

Slawson, H. H. "New Light on Ancient Technical Progress." *The Scientific American* 153: 10–11; July, 1935.

Excavations by the Oriental Institute of the University of Chicago in the Tigris Valley near Bagdad have thrown new light on the technical progress of mankind and indicate that man's mastery over matter began at least a thousand years earlier than dates commonly assigned. Excavations in the Tigris Valley have resulted in the discovery that glass, iron weapons, bath rooms, the arch, and modern tiling were all in use as early as 2700 B. C. —C.M.P.

McFayden, Audrey D. "Patent No. 2,000,000," *Popular Science Monthly* 127: 11–13; 102–103; July, 1935.

The recent issuance of U. S. Patent No. 2,000,000 to Joseph V. Ledwinka of Philadelphia marks an important milestone in American invention. The present series began in 1836—a little less than a century ago. This was Ledwinka's 248th patent.

To be patented, the contribution must be "new, useful and involve invention." A patent gives the inventor exclusive rights to the patent for 17 years. More than 100,000 applications are now pending, an average of 900 patents being issued each week.

Edison had over 1100 patents to his credit. Elihu Thomson of the General Electric Company has more than 700 patents, Ernst Alexanderson of the same company over 250, and John Hays Hammond, Jr., nearly 300. One oil company holds nearly 1200 patents relating to the oil-cracking process. —C.M.P.

McCay, C. M., and Crowell, Mary F. "Prolonging the Life Span." *The Scientific Monthly* 39: 405–414; November, 1934.

A brief resumé, partly historical, of studies relating to longevity. Most experimentation is now being carried out with rats. Results of these experiments seem to indicate that the life span of rats is increased if the rate of growth is retarded by inadequate calories, provided an essential intake of other essential nutrients is assured. The potential life span of an animal species is unknown and greater than has been believed. —C.M.P.

Stevens, Capt. Albert W. "Exploring the Stratosphere." *The National Geographic Magazine* 66: 397–434; November, 1934.

This is the story of the ill-fated National Geographic Society-U. S. Army Air Corps Stratosphere Expedition of last July 28. The largest free balloon of all times, called "The Explorer," after reaching a height of over eleven miles, met disaster, a disaster which fortunately involved no loss of life as both the rent balloon and the men landed in a corn field near Holdrege, Nebraska. There are 41 illustrations. —C.M.P.

BEEBE, WILLIAM. "A Half-Mile Down." *The National Geographic Magazine* 66: 661–704; December, 1934.

A description of Dr. Beebe's descent in a bathysphere in Bermuda waters on August 11, 1934. A new record depth of 3028 feet was reached in this latest descent. Many strange creatures "beautiful and grotesque as figments of fancy revealed themselves at the windows of the bathysphere." There are 29 illustrations and 16 additional color paintings by Else Bostelmann. —C.M.P.

Symposium. "Science Review of the Year." *Science News Letter* 26: 388–399; December 22, 1934.

This issue of *Science News Letter* summarizes the strides made in each of the sciences during 1934. —C.M.P.

DAVID, EMILY C. "Explore Mystery Isle." *Science News Letter* 26: 314–315; November 17, 1934.

Easter Island will be invaded this year by two groups of scientists (a French-Belgian-Swiss group and an American group) who will make attempts to solve the mysteries of the great stone faces and the writing on wooden tablets. The presence of these giant stone images have long intrigued the interest of mankind and proved a baffling mystery to scientists. —C.M.P.

GEITHMANN, HARRIET. "A Forest of the Past." *Natural History* 34: 653–661; November, 1934.

This is an illustrated article on the Petrified Forests of Arizona. The forest covers about forty square miles. The geologists believe that this area was once an inland sea and that the trees which are now quartz, grew during the Triassic Period of the Mesozoic Era about 200,000,000 years ago. —C.M.P.

JOHNSON, MARTIN. "Wings Over Africa." *Natural History* 34: 597–611; November, 1934.

The author gives an account of a photographic expedition that traveled by airplane over 60,000 miles of African sky. Using the Ituri Forest region of the Belgian Congo (home of the pygmies) as a base the Johnsons (Martin and Osa) photographed much of the territory of Uganda, Sudan, Kenya and Tanganyika. Illustrated. —C.M.P.

RUSSELL, HENRY NORRIS. "How Big Is the Milky Way?" *The Scientific American* 152: 14–15; January, 1935.

The flattened disc-like shape of our galaxy is due to the centrifugal force of its rotation. It would appear that the period of rotation about the center in an orbit passing near the sun is 224 million years. The sun seems to be about two-thirds of the distance from the center of the galaxy, which has a diameter of about 100,000 light years. —C.M.P.

CROWTHER, J. G. "Near Absolute Zero." *The Scientific American* 151: 300–302; December, 1934.

The article describes the experiments in obtaining very low temperatures and the underlying principles. Professor W. J. de Haas of the University of Leyden, Holland, recently obtained a temperature within one-twentieth degree of absolute zero. —C.M.P.

DUTTON, WILLIAM S. "Motordom's Ghosts Walk Again." *The Scientific American* 151: 307–309; December, 1934.

The article is interesting primarily because of the pictures of 21 early motor cars of the late nineties and early 1900. —C.M.P.

SMITH, PHILIP H. "Diesels Stride Ahead." *The Scientific American* 151: 285–288; December, 1934.

Diesel engines are being used more and more and, in the opinion of the author, will shortly have a decided effect on many forms of industry and in all branches of transportation. It is quite likely that Diesel engines will replace the present gasoline engines of airplanes before they replace those of the automobile. —C.M.P.

NEWMAN, H. H. "Quintuplets, Quadruplets, Triplets, Twins." *The Scientific American* 152: 10–12; January, 1935.

The article discusses the problems of multiple births, their relative frequency, and the studies that are being made of them by specialists. The University of Chicago has made a special study of 21 pairs of identical twins, a study which throws much light upon the effects of heredity and environment. —C.M.P.

BOONE, ANDREW R. "Revolution Among the Lubricants." *The Scientific American* 152: 19–21; January, 1935.

A new method, using liquid propane, high pressure and a temperature about 40 degrees below zero, which makes it possible to produce high grade motor oils from low grade crudes is described in this article. This new method marks the most far-reaching innovation that has been introduced into oil refining during the last several years. —C.M.P.

JOHNSON, GAYLORD. "Touring the Winter Sky with an Opera Glass." *Popular Science Monthly* 126: 46–47; 89; January, 1935.

The author describes a method of studying and identifying the winter constellations with a home made device utilizing an opera glass and a sky time-table. —C.M.P.

READ, THOMAS T. "Iron." *Natural History* 35: 17–26; January, 1935.

The article briefly traces the history of iron from its first use by primitive man down to the present, when it forms the basis of one of the world's greatest industries. Illustrated. —C.M.P.

Hartshorne, Richard. "Coal and Iron Mining Districts of the United States and Western Europe." *The Journal of Geography* 34: 1–11; January, 1935.

The article introduces the present status of coal and iron production in the United States and Western Europe. —C.M.P.

Anonymous. "Giant Egg-Shaped Molecules Seen With a Microscope." *Science News Letter* 27: 101; February 16, 1935.

George L. Clark of the X-ray laboratory of the University of Illinois has discovered rubber molecules so large (six one-hundred-thousandths of an inch long) that they may be seen with the microscope. The new super-giant molecules weigh 500,000 times as much as hydrogen atoms and more than seven times as large as the previous estimates of rubber molecules. —C.M.P.

Anonymous. "Key to Mayan Writing Found in Long Forgotten Book." *Science News Letter* 27: 99; February 16, 1935.

A Rosetta Stone that may reveal the secrets of the Mayan hieroglyphic writing has recently been discovered in the form of a 300 year old book by a forgotten Spaniard named R. Gomesta who lived in Yucatan in the 16th century. In the book are 40 Mayan hieroglyphs translated into Spanish. —C.M.P.

Hellweg, Frederick. "Keeping Time." *Natural History* 35: 47–61; January, 1935.

This illustrated article, by the superintendent of the United States Naval Observatory, describes the intricate studies and equipment upon which the accuracy of our time pieces is based. Illustrated. —C.M.P.

Heinicke, Alfred. "Persia—A Land of Medieval Farming." *Scientific Monthly* 40: 116–121; February, 1935.

The attention of those who place a large part of the blame for the present depression and unemployment on the use of modern machinery should be called to this article on modern farming in Persia. There is no unemployment or over-production where farm machinery and methods are similar to those used in the time of Cyrus and Darius. Illustrated. —C.M.P.

Wright, F. E. "The Surface Features of the Moon." *Scientific Monthly* 40: 101–120; February, 1935.

This is a report of the progress made by the Committee on Study of the Surface Features of the Moon of the Carnegie Institution. It is one of the best articles available relating to the surface conditions, surface features and composition of the moon. There are three excellent photographs. C.M.P.

Wetmore, Alexander. "Shadowy Birds of the Night." *The National Geographic Magazine* 67: 217–240; February, 1935.

This is the tenth of a series of articles on birds of North America. There are five illustrations with 21 portraits in color from life by Maj. Allan Brooks. —C.M.P.

Harding, T. Swann. "Let Us Die Fashionably." *Scientific American* 152: 88–89; February, 1935.

The recently reported growing death rate from cancer and heart disease may only be apparent and not real. This anomaly may be true because of inaccurate reporting of cases by earlier physicians and more scientific autopsies by present-day physicians. Even now there is a tendency for deaths to be reported according to the fashion and vogue of the moment—so each of us has a good chance to die fashionably. —C.M.P.

Brooks, Charles. "Some Botanical Aspects of Perishable Food Products." *Scientific Monthly* 40: 122–137; February, 1935.

The article describes some of the types of food decay, the reasons for this decay if known, and methods used to prevent or minimize this decay. Illustrated. —C.M.P.

Montgomery, Frank A. "The Versatile Papaya." *Scientific American* 152: 86–87; February, 1935.

A new fruit is gradually taking its place in the American diet—the papaya. It is a kind of "tree-melon," rich in vitamins C and D. It can be used as breakfast food, as a salad, as a dessert, and in making jelly and marmalade. It is also used in the manufacture of rope, medicines and cosmetics. There are now several papaya plantations in Florida. —C.MP.

Skerrett, R. G. "Poplars of Promise." *Scientific American* 152: 144–145; March, 1935.

The article describes a new hybrid-poplar developed by Ralph H. McKee of Columbia University and known as the McKee Poplar. It gives great promise as the chief future source of American pulpwood. The new bybrid grows 10 to 14 times as fast as ordinary poplar, producing an 80-cord crop per acre in 12 years, making it more profitable than wheat. The McKee Poplar will grow a marketable log of 8 inches in diameter in 8 years, whereas to grow the same size log requires 58 years in the case of wild poplar, 70 years in the case of pine and 90 years in the case of spruce. As a source of cellulose for pulp, flaxstraw will produce 100 pounds per acre per year, cotton 150 pounds, cornstalks 500 pounds, best natural reforestration 125 pounds, managed pure species reforestration 2000 pounds, and the McKee Poplar 8000 pounds. Pulpwood now averages 25 dollars a cord at the mills. —C.M.P.

Anonymous. "Fog; A Million Dollar Menace." *Popular Mechanics Magazine* 63: 722–723, 128A; May, 1935.

A dense fog results in much loss when large liners have to delay in entering busy harbors

such as that of New York. This problem has been attacked in many ways. One of the most successful is the use of infra-red sensitive film. This extends visibility from two to four times. The picture accompanying this article, showing the same scene during a fog taken with an ordinary and a fog camera is a fine illustration. The camera is so devised that it will develop and fix the negatives so that in thirty seconds the operator may press a button and see the scene which has just been photographed. Attempts to dissipate fog by means of electrically charged particles or by artificially increasing the humidity have not been very successful. Other experiments are being carried on following Marconi's line of attack, using micro-radio waves to guide a ship into a fog-bound harbor.

—O. E. Underhill.

Anonymous. "Houses for Everybody." *Popular Mechanics Magazine* 63: 641–644, 136A–138A; May, 1935.

Apparently the fabricated house is just around the corner. This article describes some of the details in the construction and setting up of this new type of building. Detailed accounts of the total cost of various types of buildings are given. This type of housing seems to promise that in the near future the small salaried man may have the advantages of fireproofing, heat-insulated walls, air conditioning, plumbing and electrical devices scientifically built as an integral part of home design, at a very low cost. One may soon be able to turn in the old model for a new one every two or three years with about the same percentage depreciation as occurs in such a transaction with automobiles.

—O. E. Underhill.

Anonymous. "Air Masses Tell the Future Weather." *Popular Mechanics* 64: 498–500, 128A; October, 1935.

The new method of weather forecasting, now adopted and being experimented with by the United States Weather Bureau is based on the movement of masses of air, each with distinct characteristics and its own place of origin. The interaction of these moving masses of air produces various types of weather. This article describes how these masses are formed and move, and methods by which data in three dimensions is collected for the purpose of forecasting.

—O. E. Underhill.

SKINNER, GEORGE A. "When Children and Animals Mix." *Hygeia* 13: 684–687; August, 1935.

Animal pets hold the affections of man to such an extent that they are intimately associated with him and are commonly treated as members of the family. Since most pets are subject to the same diseases that afflict man, the transmission of disease from pets to humans often becomes a serious problem. The author discusses the care that should be used in handling dogs which may be considered typical of the care necessary for common pets. He summarizes the effective methods of safeguarding animals from diseases and thus points out ways of reducing the danger of transmission of common diseases from pet to man.

F.G.B.

STICE, LOIS. "Pasteur's Conquest of Rabies Fifty Years Ago." *Hygeia* 13: 588–591; July, 1935.

In this article, the author carries the reader through the various stages in the development of a successful method of treating rabies. The conquest over this dreaded disease was assured in the summer of 1885 when the celebrated French scientist, Louis Pasteur, successfully treated Joseph Meister, a boy who had been bitten fourteen times by a mad dog. The treatment of young Meister was followed by many other successful cases until today, the Pasteur treatment with only slight modifications can be given by any physician. This conquest over rabies marked the beginning of the science of immunology and pointed the way to control of many diseases through the use of serums, vaccines, and antitoxins. —F.G.B.

TEALE, EDWIN. "Electricity from Ocean Tides." *Popular Science Monthly* 127: 9–11, 92; August, 1935.

An illustrated article describing the $36,000,000 project for harnessing the tides of Passamaquoddy Bay in Maine. The project will give employment to 14,000 men. The generators will have a capacity of 200,000 horse-power. Storage reservoirs will assure a continuous source of power.

—C.M.P.

WOLF, WILLIAM. "Poison Murders Solved by Test-Tube Sleuths." *Popular Science Monthly* 127: 12–13, 94; August, 1935.

Methods of detecting various poisonous substances, even mere traces, are described in this article. —C.M.P.

WAILES, RAYMOND B. "Mysteries of Household Products." *Popular Science Monthly* 127: 50–51, 110; October, 1935.

The article describes a series of chemical experiments in making several common household articles. —C.M.P.

CHAPMAN, LUCIE AND WENDELL. "With Wild Animals in the Rockies." *The National Geographic Magazine* 68: 231–249; August, 1935.

Twenty-six excellent photographs supplement this interesting article on hunting with the camera in which friendly advances supplant strategy.

—C.M.P.

Anonymous. "What Can Science Do About the Drought?" *Popular Mechanics* 64: 206–207, 142A; August, 1935.

A drought research institute, possibly under governmental auspices, is needed to find a means of protection against drought. Such an institution should not attempt to control the weather as did the Russian experimenters in rain making.

It is estimated that the energy required to produce one-inch rainfall over ten square miles is equivalent to 36,000,000 H.P. applied continuously for a week. Everything we eat or wear comes directly or indirectly from plants, and plants are lavish users of water. It takes 500,000 gallons of water to raise an acre of cabbages. Measurements of rainfall, such as are needed to make a study of weather cycles and other factors, are at present inadequate. Correlation of records over the world promises a method of general forecasting of the character of the coming seasons.

—O. E. Underhill.

Miner, Roy Waldo. "Marauders of the Sea." *The National Geographic Magazine* 68: 185–207; August, 1935.

This is an illustrated article chiefly on the life and habits of the octopus, but some attention is paid to the chambered nautilus. —C.M.P.

Russell, Carl P. "The White Sands of Alamogordo." *The National Geographic Magazine* 68: 250–264; August, 1935.

The White Sands National Park of New Mexico, set aside as a national park in 1933, is a dry ocean of granular gypsum, blown about by the winds into dune-like formations. The article gives a description of the region and an explanation as to the origin of the covering of gypsum.

—C.M.P.

Bevan, W. A. "When a Snake Bites You." *Scientific American* 153: 74–76; August, 1935.

The article describes the technique developed by a group of men in the Robert B. Green Hospital of San Antonio, Texas, for the treatment of snake bites. This technique is now used by the U. S. Army and is based on prolonged mechanical suction. The value of serum treatment would seem to have been overestimated. —C.M.P.

Bowie, William. "Isostasy." *The Scientific Monthly* 41: 234–239; September, 1935.

The earth's surface has been irregular for at least a billion and a half years. The author leans to the belief that this irregularity may have been caused originally by the disruption of a portion of the earth such as might have occurred in the formation of the moon. During past geological times sediments have been deposited to a thickness of as much as 40,000 feet. The earth's surface has not cooled appreciably—not more than 100 degrees centigrade—a rate of about one degree in fifteen million years.

Isostasy is a theory assuming that the various crustal blocks of the earth's surface are in a state of isostatic equilibrium. The cause of mountain and plateau formation is the change of density of the material of the crust below areas of sedimentation. —C.M.P.

Dickman, Albert. "In Defense of Insects." *Scientific American* 153: 124–126; September, 1935.

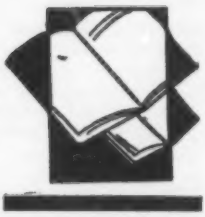
"In Defense of Insects" points out that only 300 species out of 500,000 are man's enemies. Without insects there would be no fruit, probably no human life. The article cites many interesting examples of the beneficial work of insects. "Scare-you-all" articles which envision man's defeat by the insects are perhaps a bit sensational.

—C.M.P.

Darling, J. N. "Save Our Game." *Scientific American* 153: 117–119; September, 1935.

This is a plea by the chief of the Bureau of Biological Survey of the Department of Agriculture for all Americans to become immediately interested in the problem of saving our fast dwindling wild life by providing reservations, and stopping useless swamp drainage. Game conservation has great economic value both to communities and to individuals. —C.M.P.

New publications



AGNEW, KATE E., and COBLE, MARGARET. *Baby Animals on the Farm.* Yonkers, New York: World Book Company, 1933. 153 p.

The book, *Baby Animals on the Farm* was developed while the authors were connected with the Parker District School of Greenville, South Carolina. The stories deal with the amusing adventures of Jerry and Jane during their summer visit to their grandparent's farm. There is an unusual amount of action and dialogue. There are many attractive, colored pictures portraying the amusing anctics of the baby animals discovered by Jane and Jerry. The vocabulary has been carefully graded, using Gates' list for primary grades and the words in the first fifteen hundred of Thorndike's list. This supplementary science reader is intended for the primer and first grade. Children will thoroughly enjoy the farm experiences of Jerry and Jane.

—C.M.P.

NEWBERRY, N. Y. *The Teaching of Chemistry.* London: William Hinemann, Ltd., 1934. 247 p. Six shillings.

The syllabus in general science and that in chemistry, both for English schools and each given in some detail will interest teachers in the United States. The advice and helps offered the beginning chemistry instructor are applicable in any school. Such chapter titles as The Organization of the School Laboratory, The Relative Merits of the Individual and the Demonstration Methods, Training in Experimental Techniques and School Projects, indicate that the book is quite germane to our own school set-up. Some chapters like that on Microchemistry and Small-scale Apparatus will suggest interesting techniques not commonly taught in our elementary courses. In fact the whole book is suggestive of English ways and means and should stimulate a tryout of their methods. Each chapter has a list of articles, pamphlets and books, some of which our teachers will certainly want to add to their libraries. The author is to be congratulated on his grasp of the problems involved in teaching chemistry and on his very helpful treatment of them. —E.R.D.

CLUTE, WILLARD N. *The Useful Plants of the World.* Indianapolis: Willard N. Clute and Company, 1932. 220 p. $3.75.

In *The Useful Plants of the World* the author discusses more than 500 food plants, 300 drug plants, 125 condiments and perfumes, 85 essential oils, 82 fibers, and gums, rubbers, fats, woods, beverages and stimulants, decorative plants and other useful plants in somewhat smaller proportions.

This book meets a need of science teachers whether elementary, botany or biology, and will serve as a handy reference book. Science teachers will find the answer in this book to that ever-recurring question, "What is it good for?" How nice to be able to find a scientifically correct answer! The book is recommended both as a valuable addition to the science teacher's individual library and also to the school library.

The author is a well-known botanist, being the author of several books, including Common Names of Plants and Their Meaning; American Plant Names; Botanical Essays and so on. For many years he has been editor of *The American Botanist.* —C.M.P.

THORPE, F. J. *The Faraday Books of Practical Science.* Book I, General, 1932, 136 p.; Book II, Heat, 1932, 106 p.; Book III, Chemistry of the Home, 1932, 111 p.; Book IV, Magnetism and Electricity, 1932, 101 p.; Book V, Light and Sound, 1932, 110 p.; and Teacher's Book, 1932, 206 p. New York: Oxford University Press. Books I–V, $0.60 each. Teacher's Book, $1.25.

That the English approach to the initial teaching of the physical sciences contrasts sharply to that of the average American practice is evident from an examination of the series of *The Faraday Books of Practical Science.* This series pertains to the sciences of physics and chemistry, with major attention to the former. Each book consists of a series of questions, problems and experiments. The author expresses the opinion that pupils' science books err chiefly in two ways: (1) They tell the pupil too much; by reading the book he can find out the result of the suggested experiment before he does it; and (2) They tell the pupil too little; the pupil is told to carry out an experiment without any idea of the real problem he is attempting to solve. This series of books is intended to avoid either of these extremes. It is the author's belief that too much emphasis on measurement exercises in the early part of the course has exerted a baneful effect. The author says, "Modern writers on science teaching seem agreed on three points: (a) that

discovery must precede dogma; (b) that the historical and biographic—the humanistic—aspects of science must receive more attention than heretofore; and (c) that although there must be a large proportion of individual work, and the best approach to a problem is often better made through the practical application than by the old method of taking the principle first, and then seeking its practical application afterwards, yet individual work must be guided, in other words the teacher still has to teach."

The teacher's book is to supplement the pupil's book. Additional questions, problems, experiments and explanations are given. American teachers of science, especially on the elementary- and junior-high school levels will find many suggestive problems and experiments. Many of the experiments are now found in Aemrican secondary-physics textbooks and manuals. —C.M.P.

Simonds, William Adams. *Edison, His Life, His Work, His Genius.* Indianapolis: The Bobbs-Merrill Company, 1934. 364 p. $3.50.

This is a very readable and entertaining biography of the great inventor. It deals in large measure with the more personal side of Edison's life and character. There is some evidence of hero worship on the part of the author. If the book is to be used as library material for the reading of high-school boys this probably is not objectionable.

There are almost no technical details concerning the various inventions described as the story develops. Teachers of science courses will find the book useful as stimulating supplementary reading but should not expect it to contribute to the understanding of such inventions as the electric lamp, the phonograph, or the moving-picture projector. The book is as much in place in the reading lists of the English courses as it is in the lists posted on the bulletin boards of science classrooms. Indeed, various teachers of history may well recommend it for reading also.

There are interesting annotations gathered at the end and the book is well-documented in the historical and biographical sense. An extensive bibliography of materials dealing with Edison's life and work is included.

The book is recommended for the general reader and for high-school boys from the ninth-grade up. Those purchasing books for high-school and college libraries should give it serious consideration. —R.K.W.

Meister, Morris. *Children's Science Fair of The American Institute: A Project in Science Education.* New York: The American Museum of Natural History, 1932. 48 p. $0.25.

Each year, since 1928, a children's science fair has been held in the American Museum of Natural History under the auspices of the American Institute, and in cooperation with the School Nature League and The Aemrican Museum of Natural History. This pamphlet describes the Children's Science Fair, setting forth something of its history, the values derived from such fairs, how it relates to the science program of New York City schools, the techniques of administering the fair, and a description of some of the projects and models exhibited. Every science teacher interested in science-club work will be interested in this publication. The techniques utilized here are as applicable in other school systems. Far too many science teachers are neglecting to make use of a valuable adjunct to increase interest in their science teaching (both by pupils, parents and the general public) and a device that will serve to stimulate a higher level of science attainment on the part of pupils.

—C.M.P.

Beauchamp, Wilbur L. *Instruction in Science.* Bulletin, 1932, No. 17, Monograph No. 22. Washington, D. C.: Superintendent of Documents, 1932. 63 p. $0.10.

This is one of a series of Bulletins of the National Survey of Secondary Education. The chapter headings are as follows: 1. Sources of Data; 2. Preparation of Courses of Study; 3. Educational Objectives Listed in the Courses; 4. Organization of Courses in Science; 5. Organization of Courses in Various Subjects; 6. Selection of the Subject Matter; 7. Suggestions on Instructional Techniques; 8. Types of Problems in Classroom Teaching; 9. Conclusions.

Among the general conclusions to the study may be enumerated the following: (1) The data presented indicate that, in general, the courses of study are not based upon an adequate and clear-cut theory of education; (2) The data presented raise the question of whether or not it is advisable to proceed in the revision of existing courses of study until more evidence is obtained to serve as a basis for such revision; (3) Observation of classroom teaching and the different suggestions given in the courses of study indicate great confusion as to the methods employed in science teaching; (4) There are a number of innovating practices which should be critically examined when considering changes to be brought about in current methods of science teaching. —C.M.P.

Davis, H. McVey. *The Use of State High School Examinations as an Instrument for Judging the Work of Teachers.* New York: Bureau of Publications, Teachers College, Columbia University, 1934. 101 p. $1.50.

Judgment of teacher success by pupil success in passing state examinations in particular subjects was used to discover the effects of certain factors of teacher success. State examination grades in Minnesota were used in all comparisons. Those for New York were used in one, that involving teacher experience.

Using the criteria set up, data indicated that the following factors made for pupil, therefore teacher, success: longer tenure in a given school; greater teacher turnover in a school system; better salaries after the first year; longer teaching experience under certain limits. Factors investigated which did not lead to greater success in passing state examinations by pupils were

greater amounts of specialized teacher training, and qualified as compared with unqualified teachers who were teaching the various subjects. Teacher success was estimated from per cent of pupil failure as well as from median and mean scores of contrasted groups. —A.W.H.

National Education Association of the United States. *Proceedings of the Seventy-Second Meeting.* Volume 72, 1934. 1006 pages. $3.00.

This book includes abbreviated forms of all addresses and committee reports given at the general sessions and departmental meetings for both the Cleveland and Washington conventions in February, and June and July, 1934. In addition, there are 195 pages of association records and other information.

Besides the general sessions, the following departments are represented: National Council of Education, Administrative Women in Education, Adult Education, Art Education, Business Education, Classroom Teachers, Deans of Women, Educational Research, Elementary School Principals, Kindergarten - Primary Education, Lip Reading, Music Education, Rural Education, Health and Physical Education, Science Instruction, Secondary Education, Secondary School Principals, Social Studies, Special Education, Superintendence, Supervisors and Directors of Instruction, Supervisors and Teachers of Home Economics, Teachers Colleges, Visual Instruction, and Vocational Education.

Abstracts of addresses of 265 speakers may be found representing almost every conceivable field of education. It is a book well worth having. —A.W.H.

RAGSDALE, CLARENCE E. *Modern Psychologies and Education.* New York: The Macmillan Company, 1932. 406 p. $2.25.

Every teacher who wishes to understand better the psychological theories which underlie education will find this book very helpful. In the first part of the volume the author presents an impartial and brief but clear analysis of theories advanced by modern schools of psychology. This is followed by a discussion of current problems in education, viewed in the light of psychological theories.

The differences between contemporary schools of psychology are not emphasized as much as are their individual contributions to education. Hence, the reader profits by a competent selection of pertinent material in his field, and is spared the lengthy discussion of conflicting theories that commonly appear in more extended treatments of different schools of psychology.

No bibliography is given; the author refers in the text to psychologists rather than to books. —W. I. Pearman.

LEONARD, JONATHAN NORTON. *Tools of Tomorrow.* New York: The Viking Press, 1935. 310 p. $3.00.

This is a review of technical developments and a prediction of what the future may hold in store. The features of the book include sources of power and its utilization; metals, especially alloys; machines for general use and for transportation and communication; and finally a suggestion of some of the changes which must be made "before we can enjoy the ease and luxury which applied science offers us."

One contrast of the present with the past is that we have learned to use energy from natural resources in place of energy from muscles of men and beasts of burden. With recognition of the fact that our civilization is dependent upon mechanical energy, the author turns to present sources of energy and estimates how much we have in store for future use. The sources analyzed include fuels, falling water, tides, volcanoes, wind, solar radiation and atoms. The conclusion which seems supported by convincing evidence is that there is an abundance of power for every conceivable need. Our needs for far into the future may be met by coal and water-power. Another feature of the power problem is distribution. The author supports the thesis not only that we have an abundance of power but also that it may be distributed for use as needed.

In his treatment of metals, as in the treatment of power, the author supports the conclusion that there are abundant supplies. "No important metals," he says, "are becoming appreciably scarcer." Furthermore he says, "the total disappearance of any single metal would cause little difficulty. The metallographers would be quick to design a new alloy to fill the gap."

With abundance of power and metals, the limits placed on technological developments are the ability to use and the ability to meet the social and economic problems associated with use. The problems of the future are set in large part by technology. We shall understand and shall be able to deal with these problems if we understand the conditions out of which they have arisen. For its contribution to this understanding, *Tools of Tomorrow* is a timely book. —S.R.P.

CARVER, THOMAS NIXON, WOOLMAN, MARY SCHERICK, AND MCGOWAN, ELLEN BEERS. *"Textile Problems for the Consumer."* New York: The Macmillan Company, 1935. 175 p. $1.60.

This is a brief presentation of the economics of textile consumption from three view-points: 1 Application of the general principles of pure economic to consumption; 2. The relation of these principles to the daily problems of the consumer of textiles; and 3. The aid which scientific knowledge, based upon laboratory test, may bring to a solution of these problems. The book should be useful to the general consumer who seeks to be intelligent in the purchase and use of textiles.

The third part of the book, which has been written by Professor McGowan of Teachers College, Columbia University, should prove of very great interest and usefulness to the high school chemistry teacher. In this part, Doctor McGowan has included some very practical and up-to-date laboratory tests on textiles (various

methods of identifying different kinds of fibres), soaps, cleansers, stain removal, bleaches, dyes, etc. —C.M.P.

Kane, John Francis. *Picturesque America.* New York: The Union Library Association, 1935. 256 p. $2.98.

Picturesque America, largely through pictures, presents a panorama of America. No other book that the reviewer has ever seen so fascinatingly depicts the natural beauty, grandeur, and wonders of America. There are more than 250 half-tone photographic plates. Each of the outstanding scenic regions is not only presented pictorially, but something of its history, scientific explanation, its romance, with a vivid word description, is included as well. Mary Roberts Rinehart's "The Call of the Mountains" is one of many inspiring word pictures of our beautiful America. Much biology, geology and nature study may be gleaned from its pages.

As an educational book, it should be in every school library; as a personal book, it merits first place on your library table, for the enjoyment and entertainment of your friends who drop in to see you. It will make America more beautiful, more friendly, to have it on your table! The former edition, from which this was revised, was priced at fifteen dollars. —C.M.P.

Brooks, Charles Franklin. *Why the Weather?* New York: Harcourt, Brace and Company, 1935. 295 p. $2.50.

The first book with this title was published eleven years ago. It is probably as well known to science teachers as any popular science book that has ever been printed. This new edition takes account of recent developments, although this reviewer expected a fuller account than is given of developments that have come as a result of progress in aviation. The book is well written. It is authoritative and, at the same time, it is a book of very great interest to general readers. It is recommended for the junior high school or ninth grade library. The detailed table of contents and the index are useful to teachers who may wish to use them for reference. —S.R.P.

Mees, C. E. K. *The Fundamentals of Photography.* 1934. 123 p. $1.00. Anonymous. *Elementary Photographic Chemistry.* 1931. 106 p. $0.50. Anonymous. *How to Make Good Pictures.* 189 p. $0.50. Anonymous. *Photomicrography.* 48 p. Rochester, New York: Eastman Kodak Company.

The first three books listed above constitute a most excellent and complete series of handbooks for both the beginner and advanced worker in photography. The reviewer knows of no series of booklets at this low price that are so helpful to the beginner. *The Fundamentals of Photography* provides an elementary account of the history and theoretical foundations of photography. Such topics as light, lenses, exposure, development, and printing are discussed, supplemented by illustrations. *Elementary Photographic Chemistry* tells about sensitized materials and processes employed in making a finished picture. The chemistry of photographic materials, development, fixation, washing, reduction and intensification, and toning are discussed at length. Many formulas are included. In *How to Make Good Pictures* the description of photographic processes has been reduced to the simplest form. There are 137 illustrations. An excellent glossary is appended.

The above three handbooks supplement rather than duplicate each other, although the same processes are covered in each booklet. *Photomicrography* is for the more advanced photographer and those interested in photography with the microscope. —C.M.P.

Price, Jack. *News Photography.* New York: Industries Publishing Company, 1932. 165 p. $2.00.

To those interested in the "news side" of photography or in taking pictures for possible sales, this book by one of the outstanding news photographers of the day is most welcome. His practical experience, which is so interestingly portrayed, will also prove useful to the beginner as well as to the more advanced photographer. This experience is given under the chapter headings of: Things Not To Do; Tricks of the Trade; Personal Experiences; The Amateur and News Photography; Pictures Wanted by Newspapers. Other chapters describe various types of news photography. Part II describes different types of cameras usually used by news photographers with chapters devoted to focusing, sighting, exposures, developing, printing, and general advice.

According to Mr. Price, the most used news cameras are a 4×5 Graphic, a 4×5 Graflex, and a 4×6 Ica. —C.M.P.

Boyer, Philip A., Clark, Arthur S., Gordon, Hans S., and Shilling, John. *A Learning Guide in General Science.* New York: Lyons and Carnahan, 1935. 335 p. $0.96.

A Learning Guide in General Science, first issued in 1934, has just been revised. (See the October, 1935, issue of Science Education for review of earlier book.) The revised edition has been somewhat expanded, and includes more cross references to more recent books in general science, and each unit is now introduced by diagrammatic illustrations. —C.M.P.

McGill, M. V., and Bradbury, G. M. *Chemistry Guide and Laboratory Exercises.* New York: Lyons and Carnahan, 1935. 374 p. $1.00.

This is a revision of one of the most widely used workbooks in Chemistry. (See December, 1934, issue of Science Education for review of earlier edition.) In this revised edition an attempt has been made to set up a "genuine problem organization which the student can understand and which the instructor can use in a prac-

tical way . . . problems are big enough to have real significance . . . and definite enough for complete understanding by the student." The approach is experimental, but maintains a close correlation between classroom and laboratory work. Especial attention is also paid to student guidance. Digrammatic sketches and an overview introduce each unit. —C.M.P.

MCGILL, M. V., AND BRADBURY, G. M. *Chemistry Unit and Review Tests, Alpha Arrangement.* New York: Lyons and Carnahan, 1935. 64 p.

This is a series of objective tests to accompany *Chemistry Guide and Laboratory Exercises* here reviewed. Items include matching, completion, multiple choice, and brief-answer types. —C.M.P.

BOYER, PHILIP A., AND GORDON, HANS S. *General Science Unit Tests—Arrangement B.* New York: Lyons and Carnahan, 1935. 80 p.

This is a series of tests made to accompany the authors' *A Learning Guide in General Science* reviewed above. The items are largely of the multiple choice type, with a few completion and short-answer items. —C.M.P.

JAFFEE, BERNARD. *New World of Chemistry.* Newark: Silver, Burdett and Company, 1935. 596 p. $1.80.

To justify the writing of another textbook in high-school chemistry, the author attempts to make "his material and methods of instruction serve the following purposes: (1) To maintain a balance between the necessary factual material of chemistry and the stimulating material relating to the great achievements of men and women of science; (2) To humanize chemistry by weaving into the text the story of the part research chemists and physicists have played in the development of chemistry; (3) To motivate the course by placing at the head of each chapter quotations from scientists and others; (4) To give such attention to general theories of chemistry as will be understood so clearly that the student may use them to unify his growing knowledge of chemistry; (5) To introduce the fundamental tools of chemistry—valence, the formula, the equation, the solution of problems—early in the text and to treat these tools with sufficient fullness to insure their efficient use throughout the course; (6) To select pictures that would illustrate not only important chemical processes, but also the development of chemistry as a phase of human achievement; (7) To provide simple and accurate diagrams; (8) To make provisions for the needs, interests, and varying capacities of students."

It is the belief of the reviewer that the author has reasonably realized his purposes. It is also his opinion that *New World of Chemistry,* as it will be used in a majority of present teaching situations in high school chemistry, is superior to any high school chemistry textbook that has been written. It is more readable, better and more significantly illustrated, well-balanced as to content emphasis, stresses the human aspects of chemistry, and pays more attention to findings in the field of psychology. —C.M.P.

WEEKS, MARY ELVIRA. *The Discovery of the Elements.* Easton, Pennsylvania: Journal of Chemical Education, 1934. 363 p. $3.00.

The Discovery of the Elements is collected reprints of a series of articles published in the *Journal of Chemical Education.* So great has been the demand for this work that the first edition has long since been exhausted and a second edition printed. Exhaustive and painstaking research was the basis for the collection of this unique and useful series of articles. Each article has an excellent bibliography and most illuminating and interesting photographs and illustrations. In all instances possible, the author has included a photograph of the discoverer of the element and other photographs connected with either the life of the author, or the discovery of the element. Each element, to whom a discoverer can be accredited, is treated historically as to its discovery. Thus we have here one of the best histories of chemistry now available, inasmuch as this method gives us inner glances into the lives and methods of work of many chemists. And chemists are human beings after all—possessed of the same frailities and petty jealousies as ordinary men!

The book is recommended as an excellent supplementary reference book to all teachers and students of chemistry who desire a touch of the human aspects of chemistry and an exact knowledge of the history and discovery of the elements. —C.M.P.

BRISCOE, HERMAN, T. *The Structure and Properties of Matter.* New York: McGraw-Hill Book Company, 1935. 420 p. $3.75.

Man's ideas as to the structure of matter took a long step forward when Democritus decided that everything is composed of atoms (even if he had no real conception of what we, today, picture an atom to be), but very little advance was made from the time of Democritus until Dalton came along with his atomic hypothesis. Then again man's idea of the structure of matter developed but little further until the latter part of the nineteenth century, but since that time developments have come so thick and fast that even the frontier thinkers in this field are never confident that they know the latest. From the simple atoms and molecules of the early nineties, the chemist of today must consider the structure and nature of the electrons, protons, neutrons, positrons, etc., which compose them. A knowledge of the structure of matter is essential to any worker or reader in the field of chemistry, and often to workers in other fields of science, especially biology and physics.

The author, presents an excellent treatise, on the present conception of the structure of matter. It is written from the chemist's point of view and while not stressing the mathematical aspects or present physical theory, it may not, by any means, be classed a "popular" book on the subject. The reviewer has found it an excellent treatise and

recommends it to all secondary chemistry teachers. —C.M.P.

CONANT, JAMES BRYANT. *The Chemistry of Compounds.* New York: The Macmillan Company, 1934. 623 p. $4.00.

The greatest advance in organic chemistry in recent years has been in the discovery of new compounds, rather than in an extension of the knowledge of the molecular structure of organic compounds. Some progress has been made in extending the knowledge of the electronic structure into the organic realm, but nothing comparable to that found in the inorganic realm. In the present work, Doctor Conant, now President of Harvard University, does emphasize the electronic structures of certain nitrogen and sulphur compounds as amine oxides, sulfones, sulfonyl compounds, isonitriles and nitro compounds. The author also initiates the course by beginning with a study of the alcohols, alkyl halides, esters, and ethers, rather than the more familiar aliphatic series, beginning with methane. That this method has the advantage of starting with more familiar present work, Doctor Conant, now President of molecular structure somewhat offsets this. Based on his experience as a student using this book, the reviewer is not at all convinced that a better approach does not exist than the one given in this treatise. The treatment relating to the sugars is excellent. On the whole, the book is a marked improvement over the organic chemistry textbooks of previous years and merits an extensive use in courses in organic chemistry. —C.M.P.

LUCAS, HOWARD J. *Organic Chemistry.* New York: American Book Company, 1935. 686 p. $3.60.

This is another organic chemistry textbook that brushed aside the traditional method of starting the course with the methane series. The first two chapters are given over to a discussion of valence, atomic structure, molecular structure and chemical constitution and properties. Ethers, esters, anhydrides, and acid chlorides are presented as a group, a rather unusual presentation. The author has attempted to emphasize principles by correlating with them sufficient facts for the understanding of a given principle. As a result, emphasis is placed upon class reactions, rather than upon reactions of individual compounds. This emphasis on relationships should somewhat minimize some of the usual difficulties in studying organic chemistry.

—C.M.P.

KENDALL, JAMES. *Smith's College Chemistry.* New York: D. Appleton-Century Company, 1935. 753 p. $3.75.

To students and teachers of chemistry, this textbook does not need any introduction. Its long usage has established its contents as authoritative information and it has become the "handbook" of many students in the field.

Many of the old chapters, like those on Radium, Atomic Energy and Atomic Structure, have been expanded into three single ones, wherein there has been added many of the new facts and discoveries relative to these topics.

Divisions of this nature will tend to facilitate the learning of the physical and general chemistry, which is involved in this elementary college text, because the facts and "big ideas" are presented in a less concentrated manner than in the old editions of this book.

This alteration of the long chapters into shorter ones will also prove to be advantageous to teachers, in that they will be able to assign definite chapters to be prepared before each lecture, since each of the new sections is of a practicable assignment length.

Innumerable minor changes and additions have been made throughout the whole volume in order to bring the text into agreement with the current practice and theory, such as, discussions on positrons, neutrons, isotopes of oxygen and hydrogen, heavy water, artificial transmutations by atomic bombardment, semi-polar or coordinate valence, the atom and wave mechanics, ortho and para hydrogen, and many other new advances in the field of chemistry.

Students and teachers will find this new edition, currently modern, authoritative, and practical, educationally and professionally.

—Jack Epstein

STONE, H. W., AND DUNN, M. S. *Experiments in General Chemistry.* New York: McGraw-Hill Book Company, 1935. 285 p. $1.60.

This is a laboratory manual for first-year college chemistry, designed to be used with any textbook. Emphasis is placed on chemical principles and applications of principles. In so far as possible, problems requiring a chemical preparation, a simple qualitative analysis, or a simple quantitative determination have been included. In so far as possible, experiments in which the required results may be predicted or taken directly from the textbook have been eliminated. The following groups of experiments have been included: general experiments, weight relations, volume relations, solutions, oxidation and reduction, and chemical principles and their applications. Altogether, the experiments seem to be well adapted to first year students who are majoring in chemistry. A great many of the experiments are suitable for high school students. —C.M.P.

JORALEMON, IRA B. *Romantic Copper, Its Lure and Lore.* New York: D. Appleton-Century Company, 1934. 294 p. $3.00.

No metal has had a more dramatic story than copper. It was the first of all metals to be used extensively, both by the ancient peoples of the Mediterranean world and by the early American Indians, who used it many centuries before Columbus paid them his first visit. Copper was probably first discovered on the island of Cyprus, hence its name. Later the famous Rio Tinto mines of Spain were opened.

Romantic Copper is a chronicle of greed, ambition, miraculous discoveries, comic rivalries,

tragic failures, and unbelievable successes. The author gives a robust, picturesque story of early copper mining in Cyprus, Spain, Michigan, the romantic story of "the richest hill on earth"—Butte, Montana; Bisbee, Cananea, Ajo, Utah, Peru, Chili, Australia, and South Africa. After reading *Romantic Copper* these great centers of copper mining will be associated with the names of certain romantic characters connected with their development. One cannot forget Senator Clark, Daley and Heinze and Butte; Douglas and the Copper Queen of Bisbee; Bill Greene and the Cananea; John Boddie and the Ajo, and others.

The book is recommended as excellent for supplementary chemistry reading. Methods of locating ore bodies, mining and refining the ore which are described, are not so technical as to discourage the many boys and girls who like to read a romantic story of adventure. At the same time, the incidental scientific knowledge gained will likely be remembered long after much of the usual dry-as-dust textbook material has been forgotten.

—C.M.P.

BAKER, ROBERT H. *When The Stars Come Out.* New York: The Viking Press, 1934. 188 p. $2.50.

This is one of the best popular books that has been written about the "grandest spectacle ever produced, the moving picture of the stars on the deep-blue screen of the evening skies." It is to be most highly recommended as a popular supplementary reader for the astronomy unit in the general science class. The author is a professor of Astronomy at the University of Illinois. The book begins with a description of the heavens as they appeared to the shepherds of old Chaldea. Then gradually it shows how men have built up their picture by study of the stars and their ways, the orderliness of the universe, the vastness of space, and the relation of the earth to it all.

There are a series of excellent maps, charts, and photographs. The photographs are made somewhat more realistic by being placed on a dark blue background. —C.M.P.

FATH, EDWARD ARTHUR. *Elements of Astronomy.* New York: McGraw-Hill Book Company, 1934. 360 p. $3.00.

This is the third revision of what the reviewer considers the most readable of all astronomy textbooks. It is as non-mathematical in treatment as is possible in a textbook in astronomy. It is recommended to the general reader, and to elementary science and general science teachers.

Positions, directions and distances on the celestial sphere and the earth are the first considerations. Many will find this chapter the most difficult in the entire book. Next consideration is given to the theory and nature of light, followed by a discussion of telescopes. Members of the solar system are next discussed, followed by discussions on the stars, our galaxy, other galaxies, structure of the universe, and cosmogony. There are 238 illustrations, graphs, and photographs.

—C.M.P.

BARTON, SAMUEL G. AND BARTON, WILLIAM H. *A Guide To The Constellations.* New York: McGraw-Hill Book Company, 1935. 74 p. $3.00.

This is the second revision of one of the best and most popular guides to the constellations extant. Part I contains a series of excellent star charts for each month of the year. Each constellation is discussed under the appropriate star chart. The brighter stars of each constellation receive such attention as will be inducive to the detection of the constellation at times when the sky is being observed. These constellation charts have only one unremedial drawback—it is impossible to include the planets. Location of the planets may only be obtained from a current star chart or their position determined from the American Ephemeris and Nautical Almanac. A most useful Table gives the correct pronounciation, meaning, and brightest stars in each constellation. Topics discussed include: magnitudes; star names; the celestial sphere; motion of the celestial sphere; twinkling; the milky way; number of stars; the sun; the moon; the zodiac; the planets; story of each constellation; constellations not visible to the United States; recommended supplementary reading in astronomy.

The book is recommended for all science libraries, to teachers of general science and to all persons interested in astronomy who desire a convenient guide to the celestial bodies. By conscientious use of this book, anyone may soon be able to recognize most of the constellations, even without the aid of some other person trained in astronomy. —C.M.P.

BERNHARD, HUBERT J., BENNETT, DOROTHY A., AND RICE, HUGH S. *Handbook of the Heavens.* New York: McGraw-Hill Book Company, 1935. 131 p. $1.00.

Handbook of the Heavens was written for amateurs by the members of the Junior Astronomy Club of the Museum of Natural History, New York. It gives simple, easily understood discussions of constellations, planets, asteroids, the moon, nebulæ, the sun, comets, meteors, double and variable stars, etc. It is probably the most complete book of its kind that is available at so low a price. To make the handbook as practicable and simple as possible for the beginner in star observation, a series of charts with only a few of the major constellations is included. There is also a very useful glossary.

In an interesting introduction, Shapley warns the amateur astronomer "not to take the science too seriously. As an avocation, there is nothing more mind-cleansing than astronomy; as a profession, it is a hard master. The young student should first discover in himself a high talent for mathematics, or for making experiments, or the possession of a constructive imagination, before he ventures to change his interest in stars and planets, lenses and mirrors, from a healthy hobby into a business." —C.M.P.

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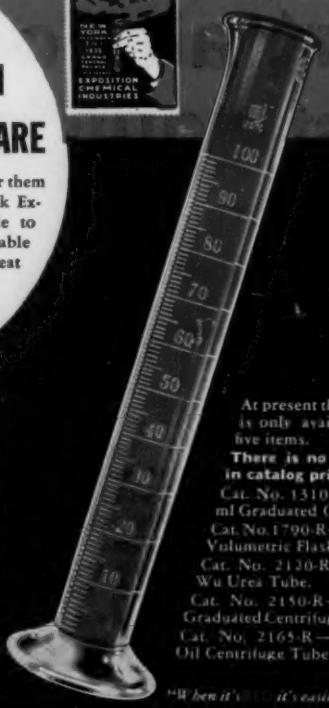

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